DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

EDITED BY EDWARD LIVEING, B.A.

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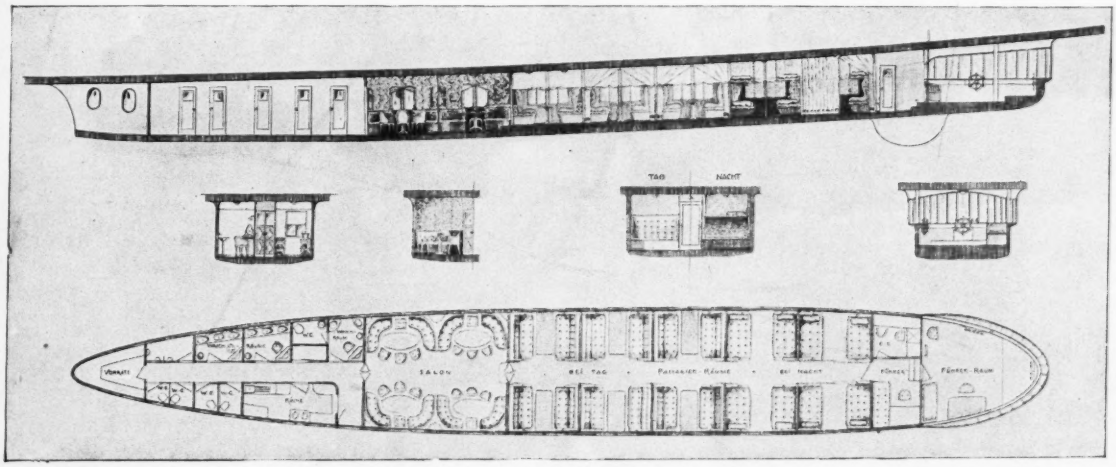

A TRANS-ATLANTIC AIRSHIP LINER

Plan of one of the huge airships to operate the Spanish Service to South America

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DISCOVERY. A Monthly Popular Journal of Knowledge.

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Editorial Notes

THE ninety-first annual meeting of the British Association for the Advancement of Science takes place this month at Liverpool during the week September 12th to 19th. In our last issue we published a short account of the addresses and discussions which will mark this year's meeting. A full account of the meeting will appear in our October number. There are obvious signs that these gatherings of distinguished scientists are beginning to gain a strong grip on the popular imagination. An increasing characteristic of the meetings is the effort on the part of those who deliver addresses to make their subjects intelligible to their audiences. Even to-day, however, despite these efforts, the highly intelligent audiences, composed largely of scientists and workers in other fields of knowledge, find difficulties in following the papers that are read from end to end—a commentary which may appear rather venturesome, but which is an admitted fact.

* * * * *

Science has become a very "specialised" concern; physics and chemistry subjects have never been easy to explain to the uninitiated; much of the language in which they are conducted to-day will not be found in any ordinary dictionaries; physiology is full of alien words; even the newer sciences of psychology and anthropology have coined their own nomenclature. All this is as it should be, so far as research is concerned. Scientific language is, in fact, a necessary medium for specialists to convey the fruits of research to other workers in the same sphere in a concise and accurate manner. But when this language, or even the slightest smattering of it, is introduced by a scientist into a supposedly popular article or paper—well, to be Irish, the article becomes thoroughly unpopular.

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Is there any way of getting over this difficulty? As we have said, the British Association has made gallant attempts to do so. Certain scientists have through a life of research retained sufficient imaginative sympathy to write of their work in their plain native tongue; even a few journalists, through a life trained to regard all events as "copy," have retained sufficient perspective and desire for accuracy to describe new scientific discoveries without undue exaggeration or inaccuracy. Both types, however, are rare, though they may well be encouraged, for they perform a work of exceptional value. A possible solution to the problem lies in the co-operation of scientists and trained writers (who can still preserve the attitude of the average man) in giving the public eminently readable books and articles on scientific subjects. At any rate, the British Association is doing admirable work in its endeavours to bring the latest results of experiment and study before that somewhat nebulous individual, "the man in the street."

* * * * *

The announcement of a new airship service to India, which the Government has decided to support, comes soon after the arrangements for a trans-Atlantic airship line between Spain and South America. Details of this Spanish scheme are given by Major W. T. Blake, the well-known airman, in this number of DISCOVERY. We are far from believing that the days of airships are over and that they have yielded place to the aeroplane in their own particular capacity for long-distance cruising. Much research has been successfully carried out during the last eighteen months with regard to the safety factors governing this form of air flight. These new services will provide safe, comfortable, and speedy travel over long distances, and they have a great future in front of them.

* * * * *

An outbreak of small-pox—the most severe for

many years—occurring in the year in which the names of Jenner and Pasteur are celebrated, is a serious commentary on the generation which, inheriting their great discoveries, has neglected to take advantage of them. A very large percentage of the population of England to-day is un-vaccinated; a very small percentage has taken the essential precaution of re-vaccination. We do not know the terrors of small-pox because our fathers took the trouble to become vaccinated; our children will doubtless rediscover them through our omission to do so. The danger involved in this simple process is probably much less than is incurred by anyone who suffers a scratch with a pin—for in that case there is always the chance of infection; while with the simple precaution of cleanliness vaccination causes at most a day or two of inconvenience.

* * * * *

It would be interesting to attempt an analysis of the mental processes of those who belong to that surprisingly large body of people who disbelieve in practically every advance in medical knowledge for the last hundred years. They are not, of course, a production of this age alone. The history of all learning is marked far more by tales of the oppression and even martyrdom of the discoverer of new things than by the gratitude of those who are emancipated or enlightened. We can always hear—

> " The cry of these ye humour
> Ah, slowly, to the light,
> ' Why brought ye us from darkness,
> Our loved Egyptian night ? ' "

The fact that there is a party in politics calling themselves Conservatives—we speak with no political bias whatever—and that they have a subdivision known as " Die-hards," who, in the words of *Punch*, yearly die in a fresh ditch, indicates that opposition to any new thing is a fixed habit of the mind of men. The simplest virtue is changelessness. " A stopped clock is right twice in twenty-four hours," but this spirit of stolid immobility, which has certainly its uses in preventing too precipitate a course of action in politics and social matters, is not the only factor in the opposition to the theories of modern medicine. There is a distortion of reasoning evident in the perpetual demand for " proof " of the efficacy of this or that process. " Proof " is a relative thing. Apart from certain mathematical statements, few facts are susceptible of " proof " in the most rigid sense of the word. Where a human factor is involved, the difficulties of proof are infinite. There are people who, like the Scotch visitor to the Zoo, can look at an elephant and say, " I don't believe it." Only a few centuries ago, " proof " in scientific matters really meant that Aristotle had made a definite statement on the point. Strangely enough, few were then sufficiently brave to say, " I don't believe Aristotle." But to-day, when each man has better opportunities of investigating the grounds for belief in a statement made by a scientist, a large number of people are ready to disbelieve it without any investigation at all.

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In the case of the treatment and the prevention of disease, " proof " is a hundredfold more difficult than in the case, for example, of a statement that a gas expands in a regular manner when heated. The doctor deals with living creatures. There is only one statement which can be made with absolute certainty about a living creature, and that is that it will die. We are not sure whether a certain sect of Christian Scientists admit even that much. The argument in favour of vaccination, of typhoid inoculation, of the germ theory of disease, rests on the record of a vast series of observations favourable to them. On the other hand, there are many facts in each case, many examples of apparent failure, which point in an opposite direction. Thus, any discussion of the efficacy of a curative or preventive method quickly becomes a battle of statistics. No one ever reads statistics. Still less does anyone verify them; they are merely the ammunition of the combat, for the vaccinationist and the anti-vaccinationist, the bacteriologist and the anti-bacteriologist. In many cases, one group of figures refers to a condition of affairs completely different from those dealt with by opposition figures. For example, anti-vaccinationists perpetually bring forward the case of the Philippine Islands, where, after many years of the apparent prevention of small-pox, it again broke out with redoubled vigour. The facts are that, during the period in which it was successfully prevented, vaccination was done by United States officials; when it broke out, vaccination was being neglected under the auspices of the local authorities.

* * * * *

Of course, the belief which a doctor or a layman holds in the value of a well-tried method of cure or prevention rests in " statistics," or facts which might be expressed as an imposing mathematical table. But that belief rests also on a wide experience, a knowledge of the thousand-and-one factors which have intruded in each separate case. There are very few doctors among the disbelievers in the theories of modern medicine. It is often said that this is because it pays them to believe in them, and to practise their teaching. Every doctor, however, knows that there is far more money to be made by following any one of a hundred will-o'-the-wisps of quackery than in the narrow path of the learning bequeathed by Jenner, Pasteur, and Lister. Life is as much a puzzle to the doctor as the weather

is to the farmer. Only a few gleams, it is true, yet appear to guide him on his way. Against him he has arrayed all the forces of anti-vaccination, anti-vivisection, anti-inoculation and anti-antisepsis. Much that he believes to-day will undoubtedly prove wrong to-morrow. At least we hope so, for it would be sad if our resources of to-day were all that we shall ever command in the conquest of pain. But what man, who sincerely studies the basis of modern belief, can doubt that the great promise of to-morrow is foretold and derived from the hard-won triumphs of the much-maligned practice and theory of to-day?

* * * * *

The recent announcement of the discoveries of bones of prehistoric monsters, at least five million years old, but beautifully preserved, in the Gobi Desert, Mongolia, must have caused surprise even to those who have carefully followed up the investigations in this region. In fact, the discovering expedition's report says that "the first month of the expedition's work is far beyond our hopes. Where we expected only fragments we have discovered an immense deposit of large and small dinosaur bones."

For many years past the possibility of enormous "finds" of early mammalian remains in Central and Southern Asia has interested zoologists and other scientists, and in this connection the discovery some years ago in Baluchistan, by Mr. C. Foster Cooper, Superintendent of the Museum of Zoology at Cambridge University, of the bones of that giant prehistoric animal, the Baluchitherium, evoked great interest. Since then the American Museum of Natural History, New York, has dispatched several successive expeditions to investigate the more central Asiatic region of the Gobi Desert. It may be recalled that the expedition of 1922 discovered vast fossil fields, rich cretaceous, tertiary deposits, the skull of a baluchitherium, the complete skeletons of some small dinosaurs, and the remains of two thousand mammals.

* * * * *

This year's expedition, under the leadership of Mr. Roy Chapman Andrews, has been even more successful. As the report of the discoveries has only just reached New York via Pekin, it is impossible as yet to give full details, but the "finds" include herbivorous dinosaurs 30 feet long of the Iguadon type, and smaller carnivorous species, the skull of a giant rhinoceros, "almost as perfect as though the animal had died a week ago," the remains of a huge dog-like carnivore, and the teeth and jaws of an "ancestral tapir-like animal." It is obvious that the expedition has made the richest "find" of prehistoric animal life ever recorded, and that this "find" almost conclusively proves that the mammalian life, which subsequently spread to Europe and America, originated in Central Asia.

A Transatlantic Airship Service

By Major W. T. Blake

PLANS for the airship service between Europe and South America have now been completed and the preliminary work is already in hand. The scheme originated in Spain, the King being largely responsible for its inception, and the company to operate the airships is Spanish, with Spanish capital.

When the scheme was mooted, the company called in the Zeppelin firm and obtained from them the exclusive right to the use of Zeppelin airships for communications between the Latin-American countries and between these and the rest of the world, among the conditions being a proviso that the ships should be constructed in Spain under the supervision of German engineers.

The technical report of the Zeppelin Company gives plans for the building of airships of a larger size than any so far constructed, though these ships are only a step towards much larger vessels when the service has proved its reliability and paying capacity. The design is for an airship of medium speed and a moderate lift.

The principal dimensions are as follows:

Capacity	135,000 cub. metres (4,500,000 cub. ft.)
Overall length	250 metres (825 ft.)
Maximum cross-section	33·8 metres (110 ft.)
Overall height	37 metres (122 ft.)
Maximum width, including airscrews	36 metres (119 ft.)
Lift	141,500 kg. (139 tons)
Useful load	75,000 kg. (73·8 tons)
Commercial load	15,000 kg. (14·75 tons)
Engines	Nine, 400 h.p. each
Maximum speed	132 k.p.h. (82·5 m.p.h.)
Cruising speed	110 k.p.h. (68·5 m.p.h.)
Range	12,000 km. (7,500 miles)
Accommodation	40 passengers, mails, and goods

Liners of the Air

The body of the ship consists of a rigid light-metal framework, fabric-covered, containing seventeen gas-bags. This framework is of the normal Zeppelin type, consisting of longitudinal girders and a system of main transverse frames with bracing, secondary frames without bracing, and diagonal bracing of the rectangular intervals between the girders. The main transverse frames divide the ship into compartments, in which the gas-bags are contained.

The usual stabilising and control surfaces are fitted. There are four pairs of engine cars identical in design, which are suspended on either side amidships, the ninth motor being situated centrally aft. The pas-

senger car is well forward of the engines, so that noise and wind need not inconvenience the traveller.

The air-screws are of wood with aluminium beading at the tips and along the leading edges. They are provided with reversing gear, and in addition with disconnecting and fixing gear.

The control car is built in with the hull and contains all over the ship. Cabins for the crew and officers are provided in the walking-way near the control car and in the stern.

The passenger accommodation is exceedingly good. The cabins and saloon are continuations of the control car, the space for passengers being 33 metres (108 ft.) long, and 5 metres (16 ft.) wide. Five cabins are

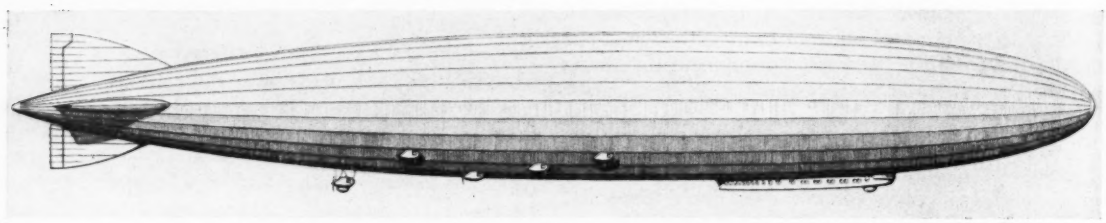

FIG. 1.—A GENERAL VIEW OF THE TYPE OF AIRSHIP TO BE EMPLOYED.

the principal controls, gas and ballast distributing boards, telephones, and navigating and other instruments, all essential installations being duplicated. The rudder-controls are in the front part of the car, and the elevator-controls on the port side. In addition there is an emergency-control station in the walking-way near the aft engine car.

Orders are transmitted to the engine cars and crew's

provided, each for eight people, and at night each cabin can be converted into two sleeping-rooms, with four berths in each. Beyond these is a dining saloon, kitchens, bar, lavatories, etc. Space for baggage, goods, and mails is provided in the walking-way. Passengers will have all the comforts of an Atlantic liner without the disadvantage of sea-sickness.

It must not be thought that these airships constitute

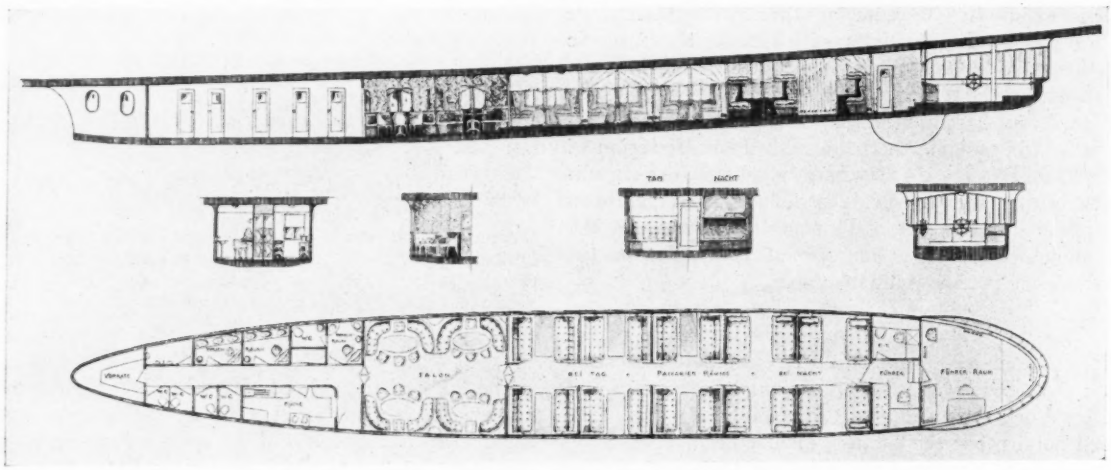

FIG. 2.—SECTIONAL DIAGRAMS OF THE AIRSHIP.

cabin by means of the engine telegraph, placed on the starboard side of the control car.

Aft of this car is a sound-proof wireless cabin and the commander's cabin. The range of the wireless is 2,000 km. (1,250 miles). Power is obtained from a dynamo driven by the wind created by the movement of the ship, which dynamo also provides electric light

the final type, as they are simply a link between existing types and the transatlantic airships of the future, which will be of about 180,000 cub. metres in capacity (6,000,000 cub. ft.), and will have a speed of 144 k.p.h. (90 m.p.h.) and accommodation for sixty passengers.

In order to give a basis of comparison with previous ships I give some figures for the L71, the biggest

German airship at the end of the war, and the British R36, the biggest proved English airship:

	L71	R36
Length	743 ft.	672 ft.
Cubic capacity	2,420,000 cub. ft.	2,101,000 cub. ft.
Engines	Six, 260 h.p.	Two, 260 h.p. Three, 350 h.p.
Gross lift	78 tons	64 tons
Range	6,000 miles	4,000 miles
Speed	75 m.p.h.	65 m.p.h.

Safety Precautions

Every possible precaution is being taken for the safety and reliability of the service. The most experienced pilots of the Zeppelin firm, each having at least a thousand flights to his credit, will be engaged, and these men will accompany the Spanish personnel until they are absolutely proficient. Every ship will carry six pilots and a commander. Engine breakdown is guarded against by having only five engines running at one time, the others being held in reserve.

A smaller type of ship will be built for school purposes, and a possible service between Spain and the Canary Islands. These airships will have the following dimensions:

Capacity	30,000 cub. metres (1,000,000 cub. ft.)
Length	144 metres (472 ft.)
Diameter	21·1 metres (69 ft.)
Total lift	31,500 kg. (31 tons)
Useful load	13,000 kg. (12·8 tons)
Engines	Three, 400 h.p.
Maximum speed	125 k.p.h. (78 m.p.h.)
Cruising speed	110 k.p.h. (68 m.p.h.)
Range	3,000 miles
Accommodation	16 passengers

Air Ports

The service is scheduled to take place between Seville in Spain and Buenos Ayres in the Argentine. At both these places huge stations will be erected, whilst intermediate landing-grounds will be provided in the Canary Islands and at Cordoba in the Argentine.

At Seville three big airship sheds will be erected, one 300 × 90 × 50 metres, the second 300 × 50 × 50 metres for the airship works, and a third 150 × 50 × 50 metres for the school airships. All these sheds will be of a fixed type owing to the regularity of the wind directions in that part of the world. In Buenos Ayres, owing to the variability of the winds, either a revolving shed 280 × 50 × 50 metres will be needed in addition to a fixed hangar, or a circular shed with sixteen doors will be built. In the Canary Islands and at Cordoba mooring masts only will be erected.

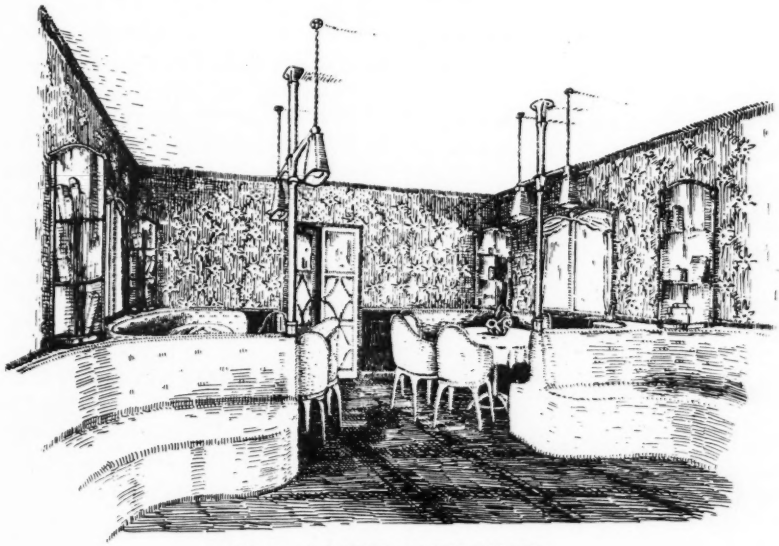

FIG. 3.—A CORNER OF THE SALOON.

The whole work of construction should take about two years, so that the service will probably be inaugurated in 1925. Services will then be made twice weekly in each direction, the journey to the Argentine taking 3 days 16 hours, and the journey to Spain 4 days 6 hours, the longer time being due to the prevailing head winds.

A fare of 6,000 pesetas (£240 at normal rate of exchange) per passenger will be charged, whilst letters will be carried at a rate of 2.25 pesetas (1*s.* 10*d.*) per package.

The French Government and the British aviation service authorities are showing great interest in the scheme, and both French and British firms have submitted offers for the manufacture of hydrogen, con-

struction of sheds, and the insurance of personnel, airships, and installations. British firms have also offered to assist in building the airship under the supervision of and in accordance with the plans of the Zeppelin engineers, using British workshops and sheds. An American firm is also negotiating for the organisation of an airship service between Buenos Ayres and Chicago.

The Secret of the Photographic Plate

By T. Thorne Baker

ONE of the most fascinating problems of modern physical chemistry is undoubtedly that of the action of light on the photographic plate. We know that an image cast by a lens upon a sensitive plate for a twenty-thousandth part of a second can produce an invisible change in the film, known as the "latent image," which at once, or years afterwards, can be converted into a negative image by the action of a suitable reducing agent.

We know, too, that there are very slow plates, used in the making of process negatives for half-tone reproduction, on the one hand, and other plates of the most extraordinary rapidity on the other, which are all made with one common sensitive substance, silver bromide.

What is the difference between the slow plate and the plate fifty times as sensitive? What is the cause of sensitiveness, and what limits the ultimate sensitiveness to be attained? These are questions to which, obviously, the research chemist of the plate factory devotes most of his attention, but during the past five years the British Photographic Research Association has concentrated a great deal of valuable work on the subject, and quite recently some really definite information has been got together and made available.

Photographing Negatives with the Microscope

If a photographic negative be examined under the microscope, the image will be seen to consist of innumerable fine "grains" of reduced silver; but if a small fragment of the undeveloped film be dissolved in water, and examined with a high power, it will be found to consist of considerably smaller grains, or actually crystals, of silver bromide. The secret of the photographic plate lies in these crystals, their formation, growth, and physico-chemical treatment. A great deal of excellent work has been done during the last two or three years in the refinement of the technique of photographing them with the microscope. By using a Pointolite lamp as light source, and preparing films one layer thick only in silver bromide crystals, images of the latter, having a magnification of as much as 3,000 diameters, can be projected with $\frac{1}{12}$-in. oil-immersion objective upon a drawing-board several feet away. The apparatus must be mounted on a vibration-free table, and with a little practice perfectly satisfactory photographs of the crystals can be obtained. The crystals are first of all focused upon a piece of white paper, and after a red light filter has been placed in the optic axis at some convenient spot, a plate is pinned to the drawing-board in the desired position, and the exposure made by removing and replacing the light filter.

When the silver bromide is first obtained—as a precipitate formed by mixing ammonium bromide solution with silver nitrate solution in the presence of gelatin—the crystals are so small that all attempts so far to resolve them have failed, and they therefore appear as spherical particles. In this preliminary form the silver bromide is in an extremely insensitive state, so much so that it may safely be exposed to weak artificial light without danger of "fogging." Hereafter follows the ripening, during which the particles gradually evince their crystalline shape and incidentally gain in sensitiveness many thousands of times.

Fast and Slow Plates

The crystals are not all of the same size, but may vary very considerably. It would appear that the larger crystals can actually absorb smaller ones and grow at their expense, though this is by no means proved. The character of the plate, however, depends largely upon the general character of the crystals. Thus if their size be fairly regular, the resulting plate will be vigorous in character, and give great contrast such as is required by the process or photo-mechanical plate. The uniformity in size will produce this type of plate even though the crystals may be of the large type usually associated with fast plates. Certain it is that in the ripening or digesting process the crystals grow to a far larger size, and that it may be said in general that the crystals in a fast plate are always larger than those in a slow one.

The plate which gives good gradation has been found to obtain a very mixed selection of crystals, the diameters probably varying as much as twenty times. Large crystals have been grown on recognised lines which have exhibited very beautiful patterns, and might possibly possess enormous sensitiveness, but their size would preclude them from being used in a commercial plate. The published work of many

experimenters shows that the increase in size and sensitiveness of the commercial crystals can be obtained by two methods, one being the heating of the emulsion to a considerable temperature, the other the digestion of the emulsion at far lower temperatures in the presence of ammonia, which is a solvent, in a slight degree, of the silver halide. But what actually happens to the crystals in the ripening process is still a mystery. One can obtain, for instance, large crystals of comparatively low sensitiveness, and small crystals of very great sensitiveness compared with the usual run of small crystals.

Slowing-up Fast Plates

Examination of the sensitive crystals by Svedberg, Toy, Sheppard and Trivelli, and others has shown that on the surface of the crystals, and frequently at the edges, are "sensitive spots" of possibly adsorbed matter, and it is assumed that these local centres are in some way responsible for the increase in sensitiveness. Clark has recently found that by treating "fast" crystals with chromic acid, and thereby removing the sensitive spots, they become greatly reduced in speed, and that crystals of different degrees of sensitiveness all appear to become reduced to one common level of speed when so treated. This would tend to indicate that ripened silver bromide, *per se*, is of a very low sensitiveness (about 6 H. and D., or probably much less), and that the speed of the plate is obtained by depositing on the crystals as many as possible of these reduction centres. What they are is

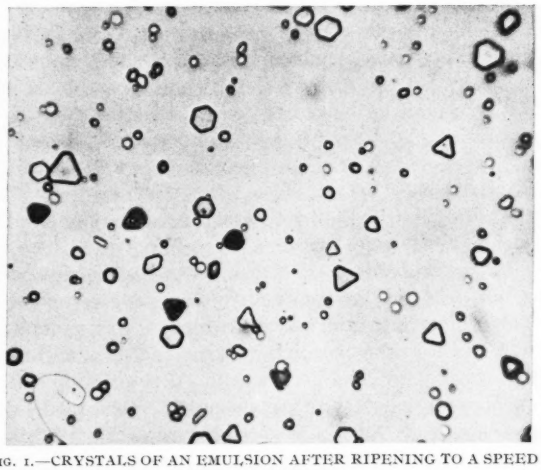

FIG. 1.—CRYSTALS OF AN EMULSION AFTER RIPENING TO A SPEED OF 50 H. AND D.

at present very uncertain. They must, of course, be derived from impurities in the water, the gelatin, or from the other raw materials used. The adsorbed matter is extremely small, and may itself be supremely sensitive and easily ionised by light, or it may behave purely as a catalyst, aiding the chemical change without undergoing change itself. If the substance

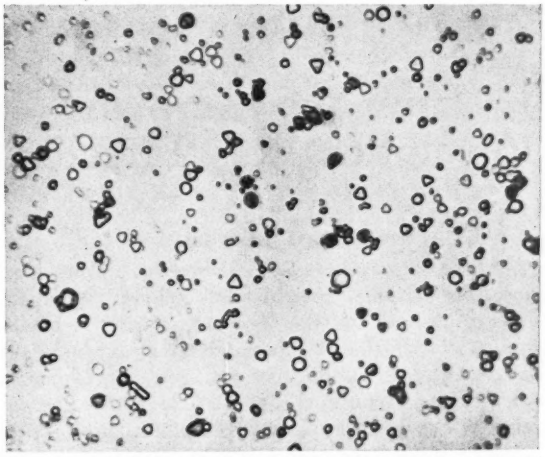

FIG. 2.—CRYSTALS OF THE SAME EMULSION AFTER RIPENING TO A SPEED OF 200 H. AND D.

be an actual silver compound, its presence within the crystal lattice may be discovered by X-ray analysis.

Effect of Light on the Sensitive Silver Bromide Crystals

A point much in dispute at the moment is the manner in which the sensitive crystals of silver bromide are affected by light. Is the crystal more sensitive the greater number of sensitive nuclei its surface presents, or can the physico-chemical character of the crystal itself make it more readily affected by the nuclei, independently of their number (or size)? Controversy exists around the theories of the character of light itself—whether it is a mere wave motion or partakes of the character of innumerable darts as propounded by Silberstein. If the light-dart theory held good—and there seems at present sufficient ground for doubting it—one would think that the area of the crystal alone would decide its sensitiveness; but this is not the case, as has been already stated.

Whatever be the actual procedure in exposure, and whatever be the character of the latent image, we have gained this knowledge as the result of recent research—that the grain or crystal size and character control the character of the emulsion, that one can to a great extent predict the ultimate character of a plate by previous micrographic analysis of the emulsion, and that the sensitiveness of the silver bromide is due to what for convenience we may call impurities deposited on or adsorbed by the crystals. That this knowledge will lead to important progress in the art of emulsion-making, and to the production of vastly more sensitive

plates for astronomical, X-ray, and other scientific work, is certain. Meantime, active research is being continued by quite a considerable number of the world's leading chemists and physicists.

How the German Revolution was Effected

By R. B. Mowat, M.A.

Fellow of Corpus Christi College, Oxford

SINCE the early years of the nineteenth century, ever since the national revival that followed upon the disaster of Jena and the occupation of Berlin by the French in 1807, there has been a large class of liberally minded people in Germany. These were mainly middle-class, educated people—patriotic, public-spirited citizens, who read about the affairs of their country and of the world, and discussed them with broad-minded intelligence. Stein and Humboldt, Niebuhr and Fichte were such men, during the period of the Napoleonic wars; such, too, were the members of the famous official family of von Gagern in the following period; such were the historians like von Sybel and Mommsen.

The Parliament of Frankfort, 1848

In 1848 this school of thinkers and others, men of action, made their fine attempt to establish a "Liberal Empire," an attempt which resulted in the famous but short-lived parliament of Frankfort. After the year 1864 the Liberals—or National Liberals as they came to be called—were pushed out of public affairs by the firm-mindedness of Bismarck. They continued to supply able officials to the civil service, and after 1871 (the end of the Franco-Prussian War) they were powerful in the new Reichstag, which, however, under the Constitution, had little more than the functions of a debating society. Although useful to the country as bureaucrats and "publicists," the National Liberals exercised no controlling influence on the policy of the Empire.

Rise of the Social Democrats

In the last twenty years of the Empire's existence the ineffectiveness of the National Liberals, who at one time seemed to have a fine future before them, left the field of official opposition open to the Social Democrats. The Social Democratic Party was active and highly organised. As the National Liberals were a democratic party based on Individualism, the Social Democrats were a democratic party based on Socialism. They were not all of the same colour; there was a right, a middle, and a left—that is to say, there were Social Democrats who were comparatively conservative (the Right); these were others who were moderately socialistic; and there were some (a fairly large section) who were frankly communist (the Left). As long as the Social Democrats were in opposition to the Imperial Government they all seemed to be tending towards the Left. They were, it seemed, the only alternative to the Cross Party—the Junkers, or official Conservatives—who filled the high places in the Imperial Government since Bismarck's time.

The Political Events of November 1918

The choice for Germany lay between the Junkers and the Social Democrats; the National Liberals were "out of the running." Therefore, when the Junker Government collapsed owing to its military failures of July–October 1918, the direction of public affairs in Germany was left inevitably to the Social Democrats. The fateful question for Germany was, "Which section would take the control, the Right, Middle, or Left?" That is to say, the choice now lay between the official Social Democratic Party (which was comparatively moderate), the Independent Social Democratic Party, and the Communists, or Spartacists. Practically the choice lay between the moderate Socialists and out-and-out Communists. Russia, faced with a somewhat similar set of alternatives in the previous year, had been taken over by the extreme Communists.

The accepted date for the German Revolution is November 5, 1918, when a naval mutiny took place at Kiel. But the army, as a whole, remained outside the revolutionary movement. The Kiel mutiny, however, acted as a signal for civilian outbreaks in Bavaria, and, on November 9, in Brandenburg. The revolution had been foreseen and prepared for during the previous five or six weeks; and when it occurred the movement was at once taken in control by the Majority (that is, the moderate), Socialists, the official Social Democratic Party.

In the early days of November, with the prospect of an armistice on practically surrender terms, the Kaiser's Government had been rocking to its foundations. On Friday morning, November 8, the executive officers of the Social Democratic Party (of whom the chief were Ebert and Scheidemann, two moderate Socialists, at this time ministers in the Imperial Government) issued an ultimatum to the Chancellor, Max of Baden, demanding the abdication of the Kaiser by midday. It was hoped by this means to avoid actual revolution. The Kaiser did in effect abdicate by fleeing to Holland on the morning of Saturday the 9th (although he did not sign his act of abdication until

November 28). On the same morning as that on which the Kaiser fled from Army Headquarters to Holland a great strike of working men occurred in Berlin and elsewhere. This was the actual moment of revolution, and this was the point at which the Majority Socialists took the movement in hand.

At 1 p.m. (Saturday, November 9) a proclamation, in the name of " The Workers' and Soldiers' Council," was issued as a fly-sheet by the newspaper *Vorwärts*, the chief Socialist organ. The *Vorwärts* had made a steady stand against Bolshevik Socialism. The proclamation announced that a large part of the Berlin garrison had placed itself at the disposal of the Workers' and Soldiers' Council; it pleaded for the maintenance of quiet and order; and ended with, " Long live the Socialist Republic ! "

This proclamation was followed within two or three hours by another, which showed the hand of the well-organised Social Democratic Party:

" Fritz Ebert, the chairman of the Social Democratic Party, has become Imperial Chancellor, and is forming in the Empire and in Prussia a new Government of men who have the confidence of the working population in town and country, of the workers and of the soldiers. Herewith public power has passed into the hands of the people. A National Assembly to settle the Constitution will meet as quickly as possible."

The Provisional Government, November 9

This proclamation showed that a self-appointed Provisional Government now existed. Prince Max of Baden left the seat of government and went to Baden; and by 8.30 p.m. the new Government was complete. It was a Cabinet of six, who had the ominous name of People's Commissaries; this name, however, was apparently almost from the first given up in favour of that of *Imperial Government*. The six were Ebert, Scheidemann, and Landsberg, Majority Socialists (i.e. members of the Social Democratic Party), and Haase, Dittmann, and Barth, Minority Socialists (Independent Social Democratic Party). The head of the Cabinet was Ebert, Chancellor, who now signed the proclamations. These proclamations, issued before the fateful evening of Saturday, November 9, came to an end, stated the programme of these relatively conservative revolutionaries. The first proclamation said:

" The Social Democratic Party has taken over the Government and has offered entry into the Government to the Independent Social Democratic Party."

It went on to state that the Constituent National Assembly would be elected by the suffrage of all citizens, both sexes, over twenty years of age. Finally it declared that human life was sacred, and that " property is to be protected against illegal interference."

This statement that property (which plainly meant private property) was to be respected, disclosed the essential mark of the Revolution, as the Social Democratic Party would have it. It was a direct challenge to the Communists, under whatever name they were known, such as Bolshevists or Spartacists. The leaders of the Social Democratic Party went further; they published (also on the night of November 9) the demands addressed to them by the Independent Socialists and their answers. In those answers the leaders took their stand wisely on the will of the people. To the demand " that Germany is to become a Socialist Republic," the answer was " it is for the People and the Constituent Assembly to decide." Another demand was: " The whole executive, legislative, and judicial power is to be exclusively in the hands of the chosen men of the total labouring population and the soldiers." The answer to this was: " If this demand means the dictatorship of a part, a class, without the majority behind it, we must reject this demand, because it would run counter to our democratic principles." A third demand was: " Exclusion from the Government of all bourgeois members." This was refused for the very practical (though not very logical) reason, that " it would seriously endanger the feeding of the people, if not make it impossible."

Germany becomes a Moderate Socialist Republic, November 12

On November 12 the definite programme of the Provisional Government was issued. It declared that the Revolution had produced a Government " whose convictions are purely Socialist." This Government, accordingly, was making certain arrangements " which will have the force of law." These arrangements were, chiefly (1) the abolition of martial law; (2) the suppression of the law of compulsory civilian service; (3) the enactment of an eight-hour day, and the increase of industrial insurance compensation; (4) a housing and unemployment scheme; and (5) the maintenance by Government of " ordered production," and protection of property " against private interference "; (6) the freedom and security of individuals. The spontaneous co-operation of the bulk of the people, the absence of any general resistance, showed that this programme had the approval of the community as a whole.

Thus, by November 12, the day after the Armistice, Germany, as the result of a Revolution, had become a Socialist Republic, based upon the principle of depending upon the whole people, of drawing its officials and representatives from every class indiscriminately, and of respecting the safety, freedom, and property of all individuals.

That the Revolution might have taken a very different course is proved by the powerful and bitter Spar-

tacist risings which took place in January and March 1919. That a stable Government and social system, based upon the normally accepted principles of European civilisation, were produced was due, chiefly, to four things. Firstly, the general will of the German people obviously was in favour of such a Government and social system. Secondly, the army leaders, headed by the potent personality of Hindenburg, who was a kind of living legendary hero, accepted the Revolution, and the soldiers followed their leaders. Thirdly, the civil service, a large, efficient machine, consisting, except in the highest posts, of educated bourgeois people, went on functioning, while the Provisional Government made no attempt to displace or " purge " it. Finally, that the Revolution was more like a peaceful transition, a normal development, was largely due to the group of resolute, moderate men who made themselves into a Provisional Government and from the first moment controlled the movement. The natural bulwarks of society should have been the National Liberals, educated, experienced, liberally minded middle-class men, such as saved France from the *Communards* after the fall of the Second French Empire in 1870. But the National Liberals, the natural leaders of the democracy, had lost their birthright when they accepted the brilliant autocracy of Bismarck's military empire. Failing the National Liberals, German society was saved by the Social Democratic Party, and chiefly by Ebert, the former saddler, who took over the Chancellorship from the hands of Prince Max of Baden on that fateful ninth of November.

[NOTE.—The chief documents concerning the German Revolution were translated and published in America by *The Living Age* on March 1, 1919. They were reprinted by the American Association for International Conciliation in April 1919. It is from these documents that the quotations made in the above article were taken.]

[Readers are also referred to an admirably lucid description of "The German Federal Economic Council," and the ideas and events that led up to it, to be found in *Representative Government and a Parliament of Industry*, by Herman Finer (Fabian Society—George Allen & Unwin, Ltd, 1923, *7s. 6d.*).—ED.]

An Alphabet of Gods

By Lewis Spence

Author of " The Gods of Mexico," " The Civilisation of Ancient Mexico," etc.

IT is a somewhat depressing commentary on our knowledge of the wonderful civilisation of the Maya Indians of Yucatan and Guatemala that, although we are aware of the names of many of their principal gods, we are still unable to identify the sculptured or painted representations of them carved on the walls of ruined temples, or depicted in the three exquisite manuscripts which are all that remain to us of Maya literature. This is largely due to the difficulties which have been encountered in deciphering the hieroglyphs which undoubtedly contain the names of these divinities. The personalities of the Maya pantheon are, of course, sufficiently familiar to us, their insignia and general significance hold few remaining secrets. But the names and titles of the Maya gods as handed down by tradition and the writings of the early Spanish missionaries we cannot apply to the carvings or pictures of divine beings with any degree of confidence, and until such time as the native system of writing is finally revealed to us, we have adopted the expedient of labelling the portraits of the gods with the letters of the alphabet from A to P.

The first student of Maya antiquities to apply this provisional and truly scientific system of nomenclature was Dr. Paul Schellhas, who so long ago as 1897 introduced it to the notice of Americanists as " a purely inductive natural science method," essentially amounting to " that which in ordinary life we call ' memory of persons.' " By an intensive examination of the pictures of gods in the manuscripts he learnt gradually to recognise them promptly by the characteristic impression they made as a whole. He was assisted in this not only by dissimilarities in face and figure, but by such details as the constant occurrence in the case of each god of some outstanding hieroglyph, ornament, or other symbol. He dealt with the figures in the manuscripts alone, and avoided all hypotheses and deductions. The present writer, following in his path, has, however, not refrained from application to those other sources of information which he ignored, and by degrees has been enabled to arrive at a rather fuller comprehension of that extensive Maya godhead to whose worship the gorgeous temples of tropical America were erected.

Schellhas candidly admitted his lack of knowledge of the places of origin of the three invaluable manuscripts which preserve for us those graceful and delicate representations of a forgotten Olympus. But Dr. H. J. Spinden, of the American Museum of Natural History, in his monumental book on *Maya Art*, has, by a careful comparison of the art-forms of those wonderful aboriginal paintings, dissipated nearly all existing doubts on the question. The Codex Dresden he assigns to the region south of Uxmal in Yucatan. In the Codex Peresianus he finds marked similarities to the art of the ruined cities of Naranho, Quirigua, and Piedras Negras in Peten, a district immediately to the south of the Yucatan peninsula. As for the Codex Tro-Cortesianus, he believes it to have been the work of a painter living in the northern district of Yucatan. It is, of course, manifest that all of these must be copies of much older manuscripts, and Spinden is of

opinion that the last-mentioned may be dated not much later than A.D. 1200. This means that all three originated in those districts which had been colonised by the Maya after they had left their original settlements in Guatemala and had been driven northward into Yucatan by racial pressure, and it is clear that all have reference to the same deities and arose out of one and the same religious impulse.

The God of Death

The god first encountered in this alphabetic sequence, God A, as he is generally described, is without doubt that grisly genius who in all mythologies presides over the realm of the departed. He is readily to be recognised by his skull-like countenance and bony spine and the large black spots, denoting corruption, which cover the emaciated body. He wears as a collar the ruff of the vulture, the bird of death, and a symbol which usually accompanies him, but which Schellhas was unable to decipher, undoubtedly represents the maggot, evidently a kind of hieroglyph for death. But the distinguishing glyph for this god is a human head with eyes closed in death, before which stands the stone knife of sacrifice. In one part of the Codex Dresden God A is shown with the head of an owl, the bird of ill omen, his almost constant attendant, and this recalls to us a passage in the *Popol Vuh*, a religious book of the Maya, which states that the rulers of Xibalba, the Underworld, "were owls," the inhabitants of a dark and cavernous place.

I believe God A to be Ah-puch, the death-spirit mentioned by Father Fernandez. His name means "the Undoer" or "Spoiler," and he was also known as Chamay Bac or Zac, that is "white teeth and bones." In some of his portraits he is decorated with a feather, on which are seen the markings of the flint knife, and I have deduced from this that the glyph for "feather" was synonymous with that "knife," a notion which I have substantiated from the fact that in Maya the first wing-feather was called "a knife."

The personality of God B is a much debated one. He has a long proboscis and tusk-like fangs, and certain writers on American antiquities have called him "the elephant-headed god." Apart from these peculiarities his eye has a characteristic rim, and he is easily recognised by the strange headdress he wears, which I take to be a bundle of "medicine" or magical appliances. And here it may be as well to say that I believe the headdresses of these gods represent the earliest symbols by which they were known to their priests and worshippers in the period before writing was invented, or hieroglyphs came into use. They would thus rank as hieroglyphs, as something to be immediately recognised or "read," and probably acted as a definite step to the invention of written symbols.

That God B has an affinity with water is plainly evident. He is seen walking on its surface, standing in rain, fishing, paddling a canoe, and even enthroned on the clouds. He is connected with the serpent, which is, in America, the water-animal *par excellence*. In some places, indeed, his head surmounts a serpentine body, and, like the priests of the modern Zuñi Indians of Arizona, he is represented as clutching tame serpents

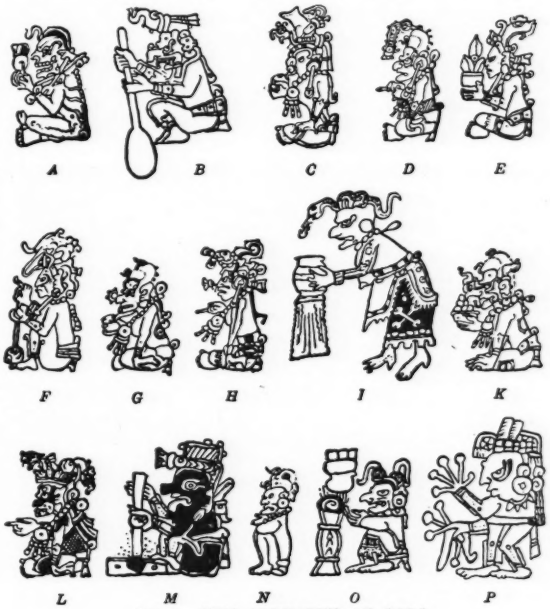

FIG. 1.—THE ALPHABET OF GODS.
(Taken from Maya MSS.)

in his hands. Like the old British god Kai—the "Sir Kay the Seneschal" of Malory—he bears flaming torches. Kai was a god of the waters; so, in some measure, is God B.

The "elephantine" aspect of this god is accounted for by his wearing the mask of the medicine-man or priest, worn during the religious ceremony. Indeed in one statue of his analogous Mexican form we see him in the very act of removing this mask. In Mexico the mask resembles the beak of a bird; in Central America it is more like a snout—whether that of an elephant or other animal I do not possess sufficient data to give an opinion.

God B is, indeed, none other than Kukulkan, "The Feathered Serpent," the Maya name for the Mexican Quetzalcoatl, the god of the rain-bearing trade-wind. But in Central America proper, whence he originally hailed, he is more intimately connected with water than with wind, and the learned priests of his cult explained him to the Spanish conquerors as "the

ripple wind makes on water," the ruffled feathers on the serpentine stream. But in later times he came to be regarded as the priest who conjured down the rain by magic, and his possession of the *calŭac*, or rain-maker's wand, places his position in this respect beyond all question.

Sky Deities

Coming to the third letter of our alphabet of gods, we find God C simple of explanation. At first sight his outward semblance may seem puzzling. His face is framed by the painted border seen on the *xamach*, or flat dish on which the Maya baked their tortillas or maize pancakes. But *xamach* also means "north," so that in this instance we have an example of that

FIG. 2.—REPRODUCTION OF PART OF A MAYA MS.
Above, Gods B and E are seen; below, a variant of Goddess I. The lesser figures in lines show the Maya hieroglyphic system of writing.

rebus-writing on which the Maya hieroglyphical system was undoubtedly based. There was, we know from tradition, a god called Xamanek, who represented the pole star, and that God C is identical with this deity scarcely admits of any doubt. In the Codex Cortesianus we see his head surrounded by a nimbus of rays which can symbolise only stellar emanations, and in the same manuscript we find him hanging from the sky in the noose of a rope. Elsewhere he is accompanied by familiar planetary signs.

In D we have a god of night and the moon. He is represented as an aged man with toothless jaws, and is indicated by the hieroglyph *akbal*, "night." His head, in the reduced cursive writing of the texts, stands for the sign of the moon, and this is frequently accompanied by the snail, the emblem of birth, over which function the moon had planetary jurisdiction. Among the Maya deities D is the only one who can boast of a beard, a certain sign in the case of the neighbouring Mexican pantheon that a god possesses a planetary significance, and for this reason, no less than because of his venerable appearance, I would collate him with Toñaca tecŭtli, the Mexican creative deity, father of the gods, the Saturn of their Olympus. This figure was known to the Maya of Guatemala as Xpiyacoc, but can scarcely be collated with Hunab Ku, "The Great Hand," the "god behind the gods," invisible, impalpable, of whom we are assured that he was represented in neither painting nor sculpture.

In God E we have such a definite picture of a divinity connected with the maize-plant that we have no difficulty in identifying him as Ghanan, the traditional Maya god of the maize, whose other name was Yum Kaax, "Lord of the Harvest Fields." He bears the maize-plant on his head, and this, becoming in course of time the conventionalised form of an ear of maize with leaves, composed his hieroglyph. His face-paint, too, frequently bears the symbol of fertility, and the rain-vase is depicted as an ornament above his ear.

God F, in his insignia, is reminiscent of the Mexican harvest-god Xipe, whose annual festival brought forth such grisly horrors of human sacrifice. He has the same distinguishing vertical face-mask, implying "war," for plenteous harvests were only to be secured by drenching the soil with the blood of many prisoners taken in battle. He is, indeed, a war-god, and is occasionally represented in full war-paint, with flint knife and blazing torch, setting fire to tents or huts. In some places he is pictured underneath a stone axe in the shape of a hand, with thumb turned upwards, which probably has an inauspicious significance.

God G is not often represented in the manuscripts. He appears to be a sun-god, and his hieroglyph, a circle enclosing four teeth, is believed by some authorities to symbolise the "biting" nature of tropical heat. His own teeth are filed to a sharp point. His head-dress recalls that of the priesthood of Yucatan, and in some of his representations has a certain resemblance to the Egyptian wig. There is, indeed, no question that it is a wig. He frequently holds the flower symbolic of a life rendered to him in sacrifice, and is occasionally depicted standing amid tongues of solar flame, a central eye blazing upon his forehead. That he is Kinich Ahaŭ, the sun-god, is scarcely open to dispute. Another of his hieroglyphs consists of a composite picture, including a solar disk, the sign *been*, which means "straw-thatch," and the sign *ik*, which in this connection is to be translated "fire which strikes upon the roof," in allusion to the frequency with which the thatched roofs of the Maya were ignited by the fierce rays of the sun of Yucatan.

A Storm-goddess

The distinguishing characteristic of God H consists in what is known as the *chiccañ* or serpent-spot appearing on his brow. He has practically no other distinctive marks, and that he has some relation to the serpent is clear. With I we come to the first of the two goddesses represented in the list—a divinity of water. She is scarcely prepossessing, and has claws in place of feet. She wears on her head a knotted serpent, and seems to pour the flooding rains from a large vessel. But she is evidently not a beneficent deity, for her face is distorted by an expression of angry menace, and it is obvious that she personifies water in its more harmful guise—the baneful flood rather than the gentle rain. In some of the representations of her water belches from her mouth, breasts, and armpits, and she wields the rattle of the thunderstorm.

Such data as we possess regarding the deity indicated by the letter K is not of a kind that would permit us to arrive at any very definite conclusions regarding him. He closely resembles B, and has even been confounded with him by some authorities. He is frequently represented on the walls of the temples of Copan and Palenque, so it follows that he must have been a divinity who ranked high in the galaxy of gods. He has the same description of mask, with elongated snout, as B, but his hieroglyph differs very markedly from the symbol of that god, representing as it does an almost ape-like head with a peculiar foliation in the region of the forehead—a constant feature of his pictures. From his position as lord of the calendar years which belong to the east, Professor Seler believes him to be Ah-Bolon tzacab, " Lord of the Nine Generations." In my view he is a variant of B. The two most famous deities among the Maya, Kukulkan and Itzamná, were undoubtedly one and the same in origin and essence, although in later times they came to be regarded as rivals and as swaying the fortune of opposing cities, and I believe K represents Itzamná as B is unquestionably Kukulkan.

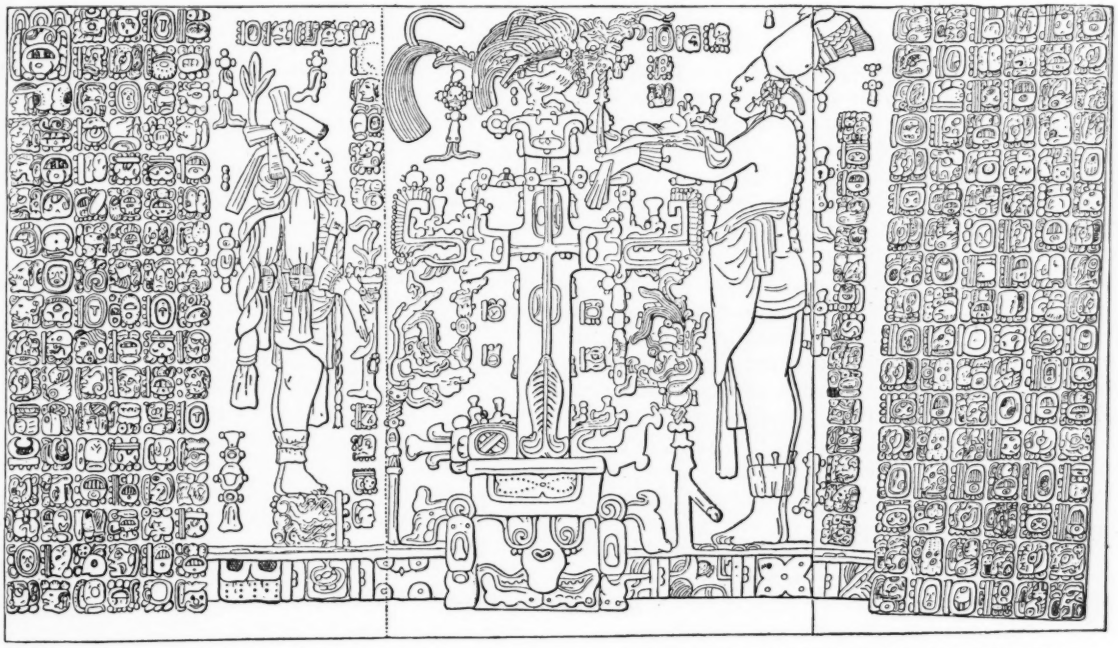

FIG. 3.—PRIEST OFFERING PASTE IMAGE OF AN INFANT TO A GOD IN THE SHAPE OF A TURKEY (PROBABLY GOD F).
The plumage of the turkey cock symbolised to the Maya the colours of rain on green vegetation. To the left stands an acolyte.

A deity of darksome hue appears in God L, known as " The Old Black God." In some of the pictures in the Codex Dresden his face is entirely black, but in the other manuscripts only the upper part of it is so painted. From the insignia which accompany him, I have been led to the provisional conclusion that he is in some manner connected with the synodical appearances of the planet Venus, which bulked largely

in Maya chronology as the basis of a time-count for the Calendar. He is also the fire-maker, who kindles the new flame with the fire-drill on the recurrence of the time-cycle.

The Maya's Mammon

In God M we have an even duskier deity, a patron of the native porters or coolies, and, like them, well-nigh black through constant exposure to the tropical sun. He has, in fact, an appearance almost negroid, thick, red lips, the lower drooping pendulously. He bears on his head a bale of merchandise secured by thick ropes. Occasionally he is drawn with the skeleton-like frame of the death-god, and this, and the circumstance that he usually carries arms, incline me to the belief that he is symbolical of the great risks run by the itinerant merchants of Mexico and Yucatan, who frequently acted as spies upon neighbouring tribes, or as the advance-guard of an invading army. He is, indeed, the god Ek ahau, or Ek chuah, "The Black Lord," a cruel and rapacious deity, whose general character reflects none too amiably upon the methods of Maya commercial activity.

God N, another aged divinity, is the god of the end of the year, and his headdress contains the sign for the year of 360 days. O is the only other goddess of the group, and her picture does not appear elsewhere than in the Madrid Codex. She also is depicted as advanced in years, and is usually represented as sitting at a loom. P, the last of the series, is easily to be recognised as the Maya frog-god, whose headdress, like that of God N, contains the sign for the year.

It is then possible to identify with reasonable likelihood six out of these sixteen figures, to label them with the traditional names they bore, and to fix the nature and characteristics of at least twice that number. This is certainly an advance, but it is not to say that we know all that is to be known regarding this galaxy of gods. The sources from which our information is drawn are tantalisingly obscure, but I would indicate two which I think have so far been insufficiently utilised. The monuments of Guatemala, Chiapas, and Yucatan contain numerous representations of deities, and these have as yet received only the most perfunctory attention. They must be more intensively examined and identified with, or differentiated from, the forms of the manuscripts. True, Maya art and its problems, and the elucidation of the hieroglyphic system, the surveying of temple sites, and the simplification of the calendar have occupied students more intimately. The other source to which they should turn is the folk-lore of the tribes of modern Yucatan, as recorded in such well-informed works as Professor Tozzer's *Comparative Study of the Maya and Lancadoñe Indians.*

REFERENCES FOR FURTHER READING

P. Schellhas, *Representation of Deities of the Maya Manuscripts.* (Papers of the Peabody Museum, vol. iv, No. 1.)
D. Brinton, *A Primer of Mayan Hieroglyphs.* (Publications of the University of Pennsylvania, vol. iii, No. 2.)
H. B. Alexander, *Latin-American Mythology.* (Boston, 1920.)
E. Seler, *Gesammelte Abhandlungen zur Amerikanischen sprach und Altertumskunde,* 5 vols. (Berlin, 1902-15.)
L. Spence, *Myths of Mexico and Peru,* 1913.
L. Spence, *The Gods of Mexico,* 1923. (For Mexican variations of these gods.)

Sleep and Sleeplessness

By D. Fraser Harris, M.D., D.Sc.

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What is Sleep?

BECAUSE a thing is very familiar it by no means follows that we know how it comes about. Possibly nothing in life is more familar than falling asleep, yet comparatively few people could tell us exactly what it is that makes people sleepy and finally permits the onset of sleep.

The fact is that healthy sleep is the result of the co-operation of several conditions or factors as physiologists call them. The most obvious thing about sleep is that, while it lasts, we are unconscious, dreaming being a more or less distinct interruption of this unconsciousness. On its mental or psychical side, then, sleep is a regularly recurring state of unconsciousness, lasting, on an average, about six to eight hours out of the twenty-four.

But this unconsciousness is the correlative of a condition of rest—inactivity—of the brain, of its most highly organised portion, known as the cortex cerebri. This cortex cerebri is the physical basis of consciousness, and therefore, when the cortex is active, consciousness is present, when it is inactive below a certain limit, there is unconsciousness.

The Rhythm of Sleep

This partial inactivity, like the unconsciousness it involves, recurs regularly, and, as physiologists say, rhythmically, i.e. at regular intervals. The rhythm of sleep is somehow related to the great cosmic rhythm of night and day, for towards nightfall animals and birds withdraw into the dark and rest, the only exceptions being those creatures of nocturnal habits—lions, jackals, owls, to name no others. A curious instance of this rhythm in regard to sleep is seen in the case

of a boy who was abandoned in the streets of Nuremberg at the age of seventeen. His childhood had been spent "in absolute solitude, having no knowledge of men, animals, or plants." He always went to sleep as soon as the sun had set.

There is no doubt that man is "intended" to rest his brain and his mind for about one-third of his life; and animals which hibernate or sleep during the winter spend one-half of their lives in repose.[1]

The Physiological Purpose of Sleep

Going to sleep is not a matter of choice; we *must* sleep just as we must eat to live; and in reality loss of sleep is more damaging than loss of food. This has been borne out by experiments and by the effects, both on men and animals, of periods either of starvation or of lack of sleep. Soldiers in the late war found lack of sleep more trying than lack of food. Sleep is therefore equivalent to some food; a person after the abstention from food of the eight hours' sleep is not nearly so hungry as a person who, awake, has not had food for eight hours.

In sleep not only is the grey matter of the highest part of the brain resting, but all the systems of the body are also relatively inactive. Thus the muscles are relaxed, the breathing is slower and shallower, the heart beats more slowly and less forcibly, the blood-pressure is reduced, the digestion is less active. Of course all this is relative; the centre for breathing in the highest part of the spinal cord cannot stop, nor can the kidneys or the liver—they are only less active than during waking; the complete cessation of their activity would mean death.

Young, immature animals sleep a very great deal; this is probably due to the fact that in immature organisms upbuilding of the tissues must prevail over disintegration, and this upbuilding in the brain has as its correlative the state of unconsciousness. Processes of repair, rest, restoration after fatigue in the central nervous system are related to sleep, so that we can understand how damaging to the nervous system must prolonged sleeplessness be.

Sleep and Death

Physiologically speaking, sleep is sharply contrasted with death. Sleep is restorative of vitality, death the extinguishing of it. We sleep to wake; we slumber in repose to work better on waking. And yet the poets see close resemblances between sleep and death, as is very well known.

Thus we have in *Macbeth* (Act II, sc. 3): "Shake off this downy sleep, death's counterfeit"; and again in *Cymbeline* (Act II, sc. 2): "Sleep, thou ape of death."

> "How wonderful is death,
> Death and his brother Sleep"—

says Shelley in "Queen Mab." Tennyson, in "In Memoriam," calls sleep "death's twin brother." And Phineas Fletcher long before had said: "Sleep's but a short death, death's but a longer sleep," all following much more ancient writers. Far nearer the truth are the beautiful words of Jesus: "She is not dead but sleepeth."

Sleep is deepest in the first hour, somewhat less so in the second, and normally much lighter in all the others. This has been investigated by physiologists, who have measured the intensity of sound or of electrical shock necessary to awake a sleeper.

The Causes of Sleep: (1) Fatigue

As regards the causes operative in bringing on sleep, the first that would occur to us is fatigue. We cannot sleep if we are not tired in some degree. Sleep due to a healthy degree of fatigue is pleasant, as we are told in Ecclesiastes (ch. v, 12): "The sleep of a labouring man is sweet." In exactly the same strain speaks Belarius in *Cymbeline* (Act III, sc. 6): "Weariness can snore upon the flint, when resty sloth finds the down pillow hard." Fatigue is, on its material (objective) side, a mild blood-poisoning (toxæmia). During the waking hours certain soluble substances produced by the muscles, the nervous system, and other tissues get into the blood, and in traversing the grey matter of the brain greatly reduce its activity. These chemical fatigue-poisons are supposed to raise the resistance to the flow of impulses over the cells of the grey matter of the brain (cortex cerebri) to such an extent that the cells cease to be active, and therefore unconsciousness supervenes. Whatever be the exact mode of action of those poisons, there is no doubt at all that extreme fatigue can bring on the most profound kind of sleep known.

We may call this factor in sleep or type of sleep the chemical. As has been said, "we stifle our brain cells with the ashes of our waking fires."

There are many examples of sleep of chemical origin through great fatigue. Thus in the good old days of muzzle-loaders in the "wooden walls," some of the gun crew would, through sheer exhaustion, lie down beside the guns which continued the cannonade at their very ears.

Philip Gibbs, in his account of the retreat from Mons, thus describes this sort of thing: "Being attacked was the only thing that kept them awake. Towards the end of this fighting they had a drunken

[1] Very interesting examples of this were given by Sir Arthur Shipley in recent articles in DISCOVERY (vide the June and July issues).

craving for sleep, and they slept standing, with their heads falling over the parapet; slept sitting, hunched in ditches; slept like dead men where they lay in the open ground. In body and brain these men of ours were tired to the point of death. When called upon to make one last effort after six days and nights of fighting and marching, many of them staggered like men who had been chloroformed, with dazed eyes and grey, drawn faces, speechless and deaf, blind to the menace about them." This is an excellent description of the results of fatigue poisoning of the brain cells. It was so profound that the centres for hearing, seeing, and speech were benumbed, or as though narcotised.

The late Mr. Stevens told us how the camel-drivers in Lord Kitchener's famous forced march to Khartoum, overcome with fatigue, fell from the camels and slept on the sand while the rest of the Army Corps thundered past them. Sentries thoroughly fatigued have fallen asleep on their feet and remained standing; postillions, in the good old coaching days, often fell asleep on horseback and yet rode on in the saddle. We recall that de Quincey wrote his "Vision of Sudden Death" after having been driven at thirteen miles an hour by a driver fast asleep on the box seat of a mail coach. More than once the cross-Channel swimmer, Holbein, has been noticed by the men in the boat to be swimming asleep. A friend of my own, a Colonel of Volunteers, told me that after undergoing twenty-two hours of extreme fatigue after the Great Review at Edinburgh in 1881, he walked home sound asleep for several miles along a familiar road in Fifeshire. This is not the so-called somnambulism, it is co-ordinated muscular activity during chemically induced sleep. A similar experience is related in Kipling's *Stalky and Co.*: "After that I went to sleep; you can, you know, on the march, when your legs get properly numbed: Mac swears we all marched into camp snoring and dropped where we halted."

Extreme misery, stimulation, or the endurance of long-continued pain finally brings on sleep. In the good old days of torture, people used to fall asleep on the rack. A vivid instance of sleep after prolonged physical and mental pain—"bullying"—is also given in *Stalky and Co.*: "When Fairbairn had attended to me for an hour or so, I used to go bung off to sleep on a form sometimes." These sleep-producing fatigue substances have not been identified by physiologists, though attempts have been made to isolate them.

Whatever their exact chemical nature may be, there is no doubt that they are similar in action to the well-known vegetable alkaloidal poisons, morphine, nicotine, curare, and atropine, substances which interfere with the passing of impulses over the cell units of the nervous system. Hence there is related to this chemical factor in normal sleep the pathological type of sleep due to drugs—narcosis—whether the drug be bromides or ether, chloroform, alcohol, chloral, sulphonal, or any of the newer hypnotics; hypnosis being but the Greek for "putting to sleep."

Lastly as to this factor we have the insomnia or sleeplessness from being "too tired to sleep." This insomnia may be due to the discomfort or pain arising from the over-exercised muscles, tendons, and ligaments, but some of it is due to the fatigue substances having an irritant instead of a hypnotic effect on sensory cells. Shakespeare, in the famous passage in *King Henry IV* (Act III, sc. 1), has contrasted the sleeplessness of the King owing to cares of state with the sound sleep of his humble subjects and also with the fatigue-produced slumbers of the tired-out sea-boy in such majestic language that the quotation of the lines will be pardoned:

"How many thousand of my poorest subjects
Are at this hour asleep! O sleep, O gentle sleep,
Nature's soft nurse, how have I frighted thee,
That thou no more wilt weigh my eyelids down
And steep my senses in forgetfulness?
Why rather, sleep, liest thou in smoky cribs,
Upon uneasy pallets stretching thee
And hush'd with buzzing night-flies to thy slumber,
Than in the perfumed chambers of the great,
Under the canopies of costly state,
And lull'd with sound of sweetest melody?
. . . . . .
Wilt thou upon the high and giddy mast
Seal up the ship-boy's eyes, and rock his brains
In cradle of the rude imperious surge?
. . . . . .
Canst thou, O partial sleep, give thy repose
To the wet sea-boy in an hour so rude,
And in the calmest and most stillest night
Deny it to a king? Then happy low, lie down,
Uneasy lies the head that wears a crown."

(2) Absence of Sensations

The second factor productive of sleep is a negative one, the *absence* of sensations. Everyone knows we get off to sleep best when we retire into the dark, shut our eyes, and exclude as perfectly as we can the distracting sounds of the outer world. Rarely can we sleep in a bright light or in a noise, or if we are suffering pain; sensations must be minimised or abolished. As we have just seen, in the sleep of extreme fatigue sensations are disregarded, but ordinary somnolence is brought about by a mild degree of fatigue co-operating with the more or less complete abolition of sensations. Any sensory stimulation can keep us awake—being too hot or too cold, or finding the bed-clothes too light or too heavy, or, of course, being in pain. This is the insomnia related to this second type of sleep. Cold feet—our own or someone else's—are a familiar cause of sleeplessness.

The onset of sleep as due to the withdrawing of

sensations is strikingly shown in a case known as "Strümpell's boy." This boy, aged sixteen, living in Leipzig, suffered from the following defects: He was insensitive to touch, he had no sense of smell or taste; he had no muscular sense, no sense of pain, and, finally, he was deaf in the right ear and blind in the left eye. When his left ear was stopped up and his right eye bandaged, he fell asleep in two or three minutes. This negative sensory sleep factor is virtually the *not* engaging of consciousness with sensory activity.

Now the existence of long-continued, not too intense sensory stimulation comes to the same thing practically as not engaging the attention at all. Thus droning reading or preaching ceases in time to engage the attention, and we fall asleep. Any long-continued sensation which does not change in intensity—contact of our clothes, the presence of still air at the temperature of the body—ceases to be a stimulus at all. Thus we can sleep in the rattle of a train or the creaking of a steamer, but as soon as either stops we wake up. The change from noise to no noise is the stimulus. Hence a person accustomed to sleep in the din of a city, often cannot get off to sleep the first night in the country—the stillness of the country being by contrast the stimulus itself.

Before we leave the second factor we might note that in the unconsciousness of deep sleep pain itself is abolished for the time being in the sense that an unconscious brain cannot perceive pain. Our chief trouble is to induce sleep in cases of great pain (neuralgias, tic douloureux, sciatica, etc.), but, having induced it, we know that the patient will obtain complete relief. Hence Shakespeare is quite right when he says: "He that sleeps feels not the toothache" (*Cymbeline*, Act V, sc. 4). Of course this is equally true of mental pain:

> "Come sleep . . . the balm of woe,
> . . . the prisoner's release"—

says Sir Philip Sidney in *Astrophel and Stella*. In the same strain, Shakespeare declares—

> "'Sleep no more! . . .
> Macbeth does murder sleep,' the innocent sleep,
> Sleep that knits up the ravell'd sleave of care,
> The death of each day's life, sore labour's bath,
> Balm of hurt minds, great nature's second course,
> Chief nourisher in life's feast."
>
> (*Macbeth*, Act II, sc. 2).

(3) Absence of Thought

Very closely allied to the absence of sensations as a cause of sleep is the third factor, the absence of thoughts, emotions, ideas, any cerebral activities, in fact. Everybody knows that anything that is on the mind will prevent sleep, whether it be joy, grief, or an unsolved mathematical problem. Thoughts we cannot banish keep us awake; the tranquillity of a mind at rest, at ease, "at leisure from itself" conduces to sleep. It is the insomnia related to this third factor that is so familiar in the sleeplessness of a "bad conscience," as it is jocularly called. It is mental activity, of course, which keeps children awake after their first visit to the menagerie, pantomime, or "hall of mysteries." The personal factor here is interesting; some people pass a sleepless night if they know they have to get up earlier than usual next morning; some condemned criminals have slept soundly the night before their execution. As long as the mind is obsessed, sleep is impossible. Sleep means inactivity of the brain, thoughts involve its activity, therefore thoughts and sleep are mutually exclusive.

> "Care keeps his watch in every old man's eye,
> And where care lodges, sleep will never lie."
>
> (*Romeo and Juliet*, Act II, sc. 3.)

Wordsworth described this insomnia of the third factor well when he addressed sleep as "Still last to come where thou art wanted most."

(4) Less Energetic Circulation

We may now inquire into the fourth and last cause of sleep, which is the diminution in energy of the circulation of the blood in the brain. Functional activity of a part depends on a certain amount of blood supplied to the part; in health the more blood an organ gets the more active it is. The brain is no exception; as its blood supply falls off, its activity is diminished until at last sleep supervenes.

Some of the evidence that the blood-supply of the brain is reduced in sleep is direct. It has been noticed through a wound of its skull that the brain (cortex cerebri) of a dog becomes paler during sleep. Physiologists have trephined the dog's skull and inserted a glass window into the aperture. They have noticed that when the dog fell asleep the surface of the brain not only became paler but receded from the glass, which previously it had pressed upon. Every mother knows that in the infant's head there is a membranous spot (the anterior fontanelle) which moves up and down with the same rhythm as the child's breathing.

Obviously the more blood in the child's brain, the more will this membrane bulge up; now it can be seen that this membrane is depressed during sleep and raised during wakefulness. When the child cries, and so prevents the veins from the head emptying their blood easily into the heart, the blood so dammed back causes the fontanelle to bulge upwards.

The Russian physiologist, Tarchanoff, has proved

that the only position in which puppies cannot go to sleep is that in which their heads are kept lower than their bodies. The retina in the interior of the eye is a part of the brain ; if the retina be examined with the ophthalmoscope by someone who is familiar with the blood-supply of the eye of a waking person, it will be found in sleep to be distinctly paler.

The rest of the evidence is more indirect, but to the physiologist equally cogent. The Italian physiologist Mosso contrived to make a man go to sleep balanced accurately on a plank or table ; as the man fell asleep the end of the table where the feet were dipped down through an angle corresponding to about the weight of 260 c.c. of blood. Evidently this is due to a redistribution of the blood, there being relatively less at the head end and more at the feet end of the body.

This redistribution of blood during sleep may be studied in yet other ways. We all know that the skin is flushed in sleep, noticeably so in children and persons with transparent skins—hence the " sleeping beatuy "—but this means that if now the skin holds more blood, the brain will be holding less.

A Russian physiologist has proved that the pressure in the carotid arteries of dogs asleep is less than during waking. The American physiologist Howell has proved, by a delicate apparatus in which he enclosed the arm of a sleeper, that as he fell asleep the blood in the arm was increased, and therefore had been diminished in the brain. It seems clear, then, that the cutaneous and cerebral blood supplies can vary simultaneously in opposite directions.

But the skin is not the only place where the blood which is leaving the brain may be found ; some of it may be accommodated in the internal organs, especially those of digestion. One has only to recall the sleepiness that many people experience after a full meal, for the simple reason that the stomach in active digestion needs a great increase of blood which it must withdraw from the brain.

In the last analysis it is the fall of blood-pressure in the vessels of the brain which is the vascular factor leading to somnolence, and therefore anything which reduces the pressure tends to sleep. Thus before an attack of sea-sickness blood is leaving the head, as is shown by the pallor of the face ; most of us know that we feel decidedly sleepy before the vomiting occurs. Persons exposed to extreme cold become very sleepy through the enfeeblement of the heart devitalised by the low temperature. Old people, owing to the weakness of their cerebral circulation, often drop off to sleep, especially when tired and in a sitting posture. This was noticeably so during the last few months of the life of Queen Victoria, who would frequently be found asleep in the carriage on her afternoon drive.

Evening, and its Accompaniments

We may now ask ourselves why it is that as evening comes on the skin and intestinal organs are accommodating relatively more blood than earlier in the day. The answer is that the small arteries of these systems are losing some of the tone they had earlier in the day. Most people have noticed their collars, rings, etc., feel tighter towards evening. Vessels whose tone is diminished dilate, and therefore hold more blood than before ; in this way the dilated vessels of the skin and viscera accommodate blood which was previously in the brain, and therefore sleep results.

Finally, it may be asked, " Why do these vessels dilate towards evening ? " The answer is, the nerve centre whose duty it is to keep them partially contracted is somewhat fatigued and fails to keep them as fully constricted as it did earlier in the day. The insomnia related to this vascular factor is very familiar. If the heart is beating too rapidly and strongly, it maintains so vigorous a flow of blood through the brain that the cells there are kept in a state of activity which, as we have seen, is incompatible with sleep.

Anything which spurs on the heart to increased effort is inimical to sleep. Thus the stimulant effects of violent exercise, of certain drugs, of not excessive quantities of alcohol, of blood raised one or two degrees in temperature, are all in the direction of banishing sleep. The well-known hypnotic effect of alcohol in hot water (toddy), or of hot milk, or of hot milk and alcohol is entirely due to the vascular factor, for these warm foods cause so abundant a dilatation of the vessels of the stomach that blood is withdrawn from the brain and somnolence ensues. The mere fact of going to bed hungry is a source of sleeplessness due to the positive sensory factor, i.e. hunger ; but the partaking of a particularly indigestible meal shortly before bedtime is, by reason of the unusually violent muscular movements aroused in digesting it, a much more serious source of a sleepless night.

A hot bath, in that it dilates the vessels of the skin and so lowers cerebral pressure, is an excellent hypnotic ; and the Turkish bath with its subsequent massage is still more soporific.

What Causes Insomnia ?

It is extremely probable that the onset of healthy sleep is due to the co-operation of all the four factors which we have discussed. Thus the mind being free from too obtrusive thoughts and sensations, and there being a certain degree of brain fatigue, a fall of cerebral blood-pressure occurs and the person falls asleep.

The reversal of any of these four conditions—psychic, sensory, fatigue, or vascular—will involve the corresponding insomnia.

Of course any given attack of sleeplessness may be due to the co-operation of two or more sleep-banishing factors. Thus if a person is in a state of emotional unrest, this condition acts on the heart, stirring it up to increased effort, with the result that an insomnia is produced which *could* have been produced by either factor alone.

Varieties of sleep related to the vascular factor are the condition in fainting (syncope), and that brought on by compression of the carotid arteries—a method successfully used to induce sleep in a maniac; both, of course, are abnormal, or, as we say, pathological.

This is not the place to enter upon the hygienic aspect of sleep and sleeplessness; but we must allude to the devitalising effects of fatigue especially when coupled with sleeplessness. Both predispose us to ill-health, in that they reduce the resistance of the organism to the onslaughts of the micro-organisms that cause disease.

The new-born infant sleeps much; its brain is too immature to perform the functions of full working life, and so more than one-third of its life is passed in sleep. At the other end of life's drama it happens most often that the curtain falls while we sleep, so that Shakespeare was doubly justified in exclaiming, "Our little life is rounded with a sleep."

REFERENCES FOR FURTHER READING

Marie de Mendecine. *The Physiology, Pathology, and Psychology of Sleep.* (International Science Series.)
Howell. *Textbook of Physiology.* Chapter on Sleep.

Animal Fecundity—II

By F. H. A. Marshall, Sc.D., F.R.S.

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In considering the factors which control the quantity of offspring produced by animals, it must be borne in mind that the fertilised egg cell, whether of a fish or an insect or any other animal, is the product of union of a single ovum or female reproductive cell with a single sperm or male reproductive cell. The egg, as a consequence of this process, becomes endowed with a new vitality, whereby it is rendered capable of undergoing that long series of cell divisions which results in the full development of a new individual organism. Now in the higher animals the number of eggs which are shed from the female reproductive gland is limited, in some species only a single egg being discharged at a time. In the male animal, on the other hand, the number of reproductive cells produced and shed from the generative gland runs to many thousands, the purpose being to increase the chances of the ovum becoming fertilised; this is an example of the extraordinary prodigality of Nature in seeking to accomplish her ends, the ultimate object in this case being the perpetuation of the race.

Fecundity of Domestic Animals

Among the domestic animals, the mare and the cow usually discharge only one ovum at a time, and upon this depends the fact that with these species only one young one is usually produced at birth. With the rabbit, on the other hand, there are sometimes as many as eight ova shed synchronously from the reproductive gland, and in the pig as many as fifteen or even twenty or more ripe ova are produced. Upon this depends the well-known fact that these animals often produce large litters, the number in each litter generally corresponding closely, but not necessarily exactly, with the number of ova discharged. Since the number of male cells produced is, as a rule, extremely large, it follows that, generally speaking, the female is a more important factor in the quantity of offspring produced than the male. This rule, however, is not invariable, but in a large percentage of instances it is certainly correct.

Methods of Increasing Fecundity in Sheep

In the sheep the normal number of ova discharged at a time is not appreciably in excess of the average number of births at the lambing season. This number is most frequently one, but quite commonly two, and sometimes three, but any greater number is unusual. There is direct evidence that in the sheep, as in other mammals which have been studied, a considerable number of ova die within the reproductive gland, and that this may happen at all stages in the development of the ova. Scarcity of available ova at the "tupping" or breeding season may be due either to a retardation in the growth and maturation of the ova, or to an excessive proportion having perished at some previous time, and both conditions must be ascribed to a former want of sufficient suitable nutrition. On the other hand, a favourable nutrition, especially in the period immediately preceding "tupping time," causes a larger number of ova to develop and so to become available for fertilisation, and as a consequence increases the number of births at the succeeding lambing season. What is really the practical application of this fact has been long recognised by many flockmasters, who have practised the methods of "flushing" or artificially stimulating their ewes by means of an extra supply of special food at the approach of the "tupping" or breeding season. Several years ago the Highland and Agricultural Society of Scotland

undertook an inquiry upon this subject and accumulated a quantity of statistical evidence extending over three years for flocks of Black-faced, Cheviot, Border Leicester, and cross-bred sheep. The records collected clearly showed that sheep which were fed upon oats, maize, dried grains, or turnips or other additional food at the time when the rams were turned out to the ewes and for about three weeks previously, but which were maintained upon grass only for the greater part of the year, had a better crop of lambs than sheep which were not subjected to such treatment. The percentage of twin lambs born was very perceptibly increased. Merely putting ewes upon superior pasture for a short time before "tupping," and without any special feeding, was often sufficient to increase the fertility of the flock. Among "flushed" flocks of Border Leicester or half-bred Border Leicester ewes the number of lambs per ewes was nearly 200 per cent., while for sheep of the same breeds which were not so treated the average proportion of lambs per ewes was between 150 and 160 per cent. The best condition for the breeding ewes was a good thriving or "improving" one, an excess of fat being as detrimental to fertility as a too lean condition. The effect of the practice of "flushing" or nutritive stimulation is clearly to increase the number of ova discharged at a time. Once the process of discharge is accomplished, no amount of extra feeding can increase the number of developing young, for this number is determined at the time of "tupping." An adverse circumstance during the period of gestation may reduce the crop of lambs, but favourable conditions at this season can do nothing to increase it if a sufficiency of mature ova has not previously been produced.

Influence of Male Parent

It is thus seen that in a certain sense the female parent is often a more important factor in fertility than the male, since the female usually controls the size of the litter. There is, however, another sense in which the male parent may be regarded as the more important factor. It is usual for a good stallion to mate with eighty or more mares in a season, and for a ram to mate with about fifty ewes. It is obvious, therefore, that any failure in the power of procreation on the part of the male parent may cause temporary sterility in a large number of females, and such an effect is by no means an unknown occurrence. Again, it has been sometimes found that a female who is barren with one male will be fertile with another. Thus Dorset Horn ewes, which fail to breed when put with a Dorset Horn ram, may subsequently produce lambs after mating with a Hampshire Down ram. Furthermore, Mr. John Hammond, of Cambridge, has shown that with sows the activity of the female generative gland may outstrip the capacity of the animal to produce fully developed piglings, and that a certain number of these may die and degenerate before being born. The cause of this phenomenon is still under investigation, but it seems probable that it is a question of nutrition.

Inheritance of Fecundity

Fecundity, like other characteristics, may be hereditary, and some breeds are notoriously more fertile than others. Thus among sheep the Dorset Horns are far more prolific than sheep belonging to hill breeds, even though the latter are bred amid lowland conditions. Moreover, by breeding from sheep which were twins the fertility of a flock may be increased, and the capacity to bear twins can be transmitted through the ram to the next generation of ewes of which that ram was sire in just the same kind of way as the deep-milking propensity of some cows may be transmitted through the bull to the next generation of female calves. So also Pearl has shown that the capacity to lay an increased number of eggs possessed by some strains of fowls may be transmitted through the cock.

Among the Stars

An Astronomical Commentary

The Total Eclipse of September 10

THE astronomical event of the month will be the total eclipse of the Sun on September 10. The shadow of the Moon will strike the Earth's surface in the North Pacific Ocean, just off the coast of Asia. It will then cross the Pacific, traversing the American continent by way of California and Mexico and ending in the Atlantic, just off the northern coast of South America. As the eclipse will be the most favourable visible on American territory for over twenty years, it will be extensively observed, and numerous expeditions are being fitted out by the various American observatories. The Lick astronomers will be stationed at Ensenada, and the Mount Wilson observers at San Diego, while the Yerkes Observatory station will be on Catalina Island.

In recent eclipses, the chief object of observation has been to subject the Einstein theory of relativity to observational tests. In view of the results attained last year, however, this question may now be regarded as settled in favour of the theory, and accordingly other problems which in recent years have fallen into the background will come in for their share of atten-

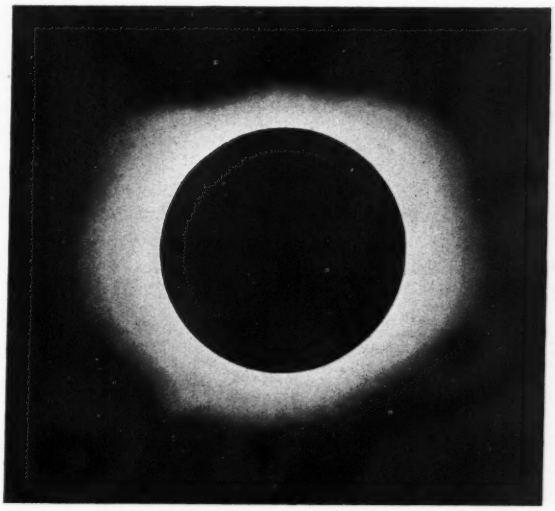
tion. First of all is the nature of the corona. Alone of all the solar appendages, the corona has defied the advance of spectroscopy and can only be observed on the rare occasion of a total eclipse. As Mr. Fath, of Goodsell Observatory, Minnesota, remarks: "We know that a portion of its light is polarised, that its spectrum consists in part of reflected photospheric light and in part of bright lines, that it rotates in the same direction as the Sun, and that its general outline changes with the sun-spot curve. We know practically nothing of the forces which determine the direction of its streamers; nothing of the real nature of the substances composing it, their source, or their motion in the streamers; nothing about its rotation except direction." Another problem is that of the existence of intra-Mercurial bodies. While it is certain that there are no objects of planetary dimensions beween Mercury and the Sun, it is not improbable that a number of asteroidal bodies may exist. Accordingly, it will be desirable to explore the solar vicinity with powerful instrumental aid. An interesting feature of the coming eclipse will be the presence of Venus in the near vicinity of the sun. Indeed, it will be possible to photograph the planet on the eclipse plates. Mr. J. H. Worthington remarks, in *Monthly Notices*, vol. lxxxiii, p. 424, that "it seems that Venus shining through the outer corona and an immense section of the zodiacal light on this occasion should offer an opportunity to study the absorption spectra of these solar appendages."

Another New Star

Mr. Lampland, of the Lowell Observatory, Flagstaff, Arizona, discovered a new star on May 5 last. The nova is situated in the spiral nebula Messier 83 (N.G.C. 5236) and is of the fourteenth magnitude. The nebula is described by Dr. Curtis, of the Lick Observatory, as a large and beautiful spiral with a very bright nucleus. This nova is evidently another of these remarkable outbursts in spiral nebulæ, of which many have been catalogued in recent years.

Dr. Anderson's "Nova Cygni"

Dr. T. D. Anderson informs me that he feels "pretty certain" that the nova whose discovery he announced three months ago is to be identified with the star B.D. 35° 4505, a star of the ninth magnitude, which is an easy object in a 2½ or 3 in. refractor. Dr. Anderson has been informed by Professor Shapley that this star is of spectral class Ao—"that is to say, it comes spectroscopically under the same category as Sirius and Vega." Professor Shapley "is engaged along with his staff in examining the photographs on which B.D. 35° 4505 appears in order to ascertain if there was any earlier outburst. I rather think the result of the search is proving to be negative." Dr. Anderson remarks that since its outburst, the nova has remained in a state of quiescence, and he maintains that the outburst has been a comparatively slight one. Can we, with the facts before us, he asks, "make bold to conclude that if novæ brighten up to the extent of only a few magnitudes, their subsidence will take only a short time and that that time will be very short indeed if the star's increase in brightness has been very small?" Dr. Anderson is so skilled an observer that his suggestion is worthy of serious consideration. Professor Turner probably voices the opinion of the astronomical world when he says that we may accept Dr. Anderson's statement as to his discovery "without hesitation,"



TOTAL ECLIPSE OF 1914, SHOWING CORONA.
Reproduced, by permission, from the "Monthly Notices" of the Royal Astronomica Society.

and that "we can scarcely doubt that he has indicated the right sort of explanation."

The Densest Known Star

The American astronomer, Mr. F. C. Jordan, announces the discovery of a remarkable eclipsing variable star. The period of variation from maximum to maximum or minimum to minimum is a little less than six hours. Like other eclipsing variables, the star is a binary or double; and a study of the light curve indicates that the components of this binary are dwarf stars of high density and elliptical in shape. The two stars being approximately equal in size, it is possible to compute the upper and lower limit values for the mean density, which Mr. Jordan finds to lie between 3·4 and 2·2 times the density of the sun. This star is, therefore, the densest star

known. Its period is in addition the shortest among eclipsing variable stars.

Death of the Cape Astronomer

There will be real regret among astronomers at the premature and unexpected death of Mr. Hough, His Majesty's Astronomer at the Cape. The Cape Observatory occupies quite a unique place in astronomy, and has been presided over by a succession of very able observers. Thomas Henderson, afterwards Astronomer-Royal for Scotland, carried through at the Observatory his parallax measures of Alpha Centauri. Maclear, his successor, continued the work and determined the distance of Sirius. In 1879 Mr. Stone was succeeded by the late Sir David Gill, under whom the Cape Observatory reached its pinnacle of fame, becoming the centre of activity for the photographic charting of the heavens. Mr. Hough succeeded Sir David Gill on the latter's retirement in 1907. Under his directorship the high traditions of the Observatory were fully maintained. Mr. Hough was a mathematician of considerable powers, and in 1897 and 1898 he carried through a highly important piece of work—the revision of Laplace's theory of the tides, which Sir George Darwin pronounced to be "the most important contribution to the dynamical theory of the tides since the time of Laplace." In collaboration with Dr. Halm, Mr. Hough exhaustively investigated the solar motion and the streaming of the stars.

HECTOR MACPHERSON.

Reviews of Books

THE REVELATIONS OF CRETE

The Minoans. By GEORGE GLASGOW. (Jonathan Cape, 4*s.* 6*d.*)

Many a traveller who has "gone east" across Italy and the Mediterranean will not readily forget how he watched from the deck of his ship the long, southern coast of the famous island which, so to speak, shuts off the Ægean Sea from the larger sea. Seen from twenty to thirty miles away, Crete's southern coast rises with magnificent abruptness out of the blue waters, finally ascending into lofty ranges with jagged peaks cloaked in snow or rendered half visible by clouds. A still more fortunate traveller is he who has taken ship along the northern coast, gazing at the green plains, studded with white villas, which recede towards the towering background of the island's mountain range, of which Mount Ida is the culminating point. It is difficult to imagine a more romantic-looking island than Crete, and to land on it is to gain impressions of mixed civilisations and religions—Turkish, Greek, and Cretan—jostling into each other amid surroundings of extraordinary beauty.

In a word, Crete is the very kind of island to provide an admirable setting for excavations leading to romantic revelations of a past epoch in the world's history. Only twenty-three years ago Sir Arthur Evans started to dig on the island, since when his own excavations and the excavations of other archæologists at Knossos, Phæstos, and other sites have disclosed, as Mr. Glasgow remarks in his opening chapter, "the existence of a people whose form of civilisation, the earliest in Europe, flourished long before history begins." This island civilisation has been established almost beyond doubt as the connecting link between the great civilisations of Egypt and of Greece. Thus within little more than two decades enormously important facts have been revealed to us which place the history of mankind in altogether new proportions. Instead of regarding the wonderful era of Greek civilisation, which lasted from about 800 B.C. to about 140 B.C., as some exotic and sudden growth, which had only slight and uncertain relations with the earlier and more materialistic civilisations of the East, we now know that this age owes a great debt to the religions and culture of the ancient Egyptians, which were passed on, being amplified in the process, through Crete to the European mainland.

Sir Arthur Evans has for several years past been recording the results of his excavations in large volumes; other archæologists have also described their work in various books. The value of Mr. Glasgow's present account, however, the substance of which was published in 1920 and 1921 in DISCOVERY,[1] lies in the fact that it gives to the ordinary reader a comprehensive, up-to-date, and concise description of the excavations and their importance in relation to the progress of civilisation. Indeed, the careful research which has gone to the making of this book is matched by the lucid manner in which that research has been expressed in writing. The age when Crete was a centre of Mediterranean civilisation begins about 2800 B.C. and ends about 1100 B.C. Thus it flourished during the Bronze Age, though man first settled in Crete at a place called Knossos during the later Stone Age, gradually moving across the island to the south side and founding colonies, such as that at Phæstos, where pottery of a superior kind to that at Knossos has been found.

It must not be imagined that Crete merely handed on the torch of culture from Egypt to Greece. Minoan civilisation is marked by definite characteristics of its own. "After Schliemann's discoveries at Mycenæ and Tiryns," as the author indicates, "the term 'Mycenæan' was used in a general sense to cover the whole prehistoric Ægean civilisation; but, now that Crete has put Mycenæ into its right perspective, the term 'Minoan' is used to indicate the earlier and greater phase, while 'Mycenæan' merely covers the latest phase; the whole being designated 'Ægean.'" Professor Elliot Smith is careful to emphasise the fact that "at the dawn of civilisation Crete occupied a unique situation, which was exceptionally favourable to the development of a high culture; and there can be no doubt that she seized her advantage and turned

[1] See DISCOVERY, vol. i, nos. 6, 8, and 10, and vol. ii, nos. 13 and 14.

it to the most profitable account. Her geographical position as a sea-girt isle was such that, while being exempt from the dominating and overshadowing influence of Egypt, she profited by both of the fertilising streams of inspiration that had their source in Egypt."[1] Neither did Crete owe the origins of her culture entirely to Egypt, for, as the same authority shows, she " was also affected in a most intimate way by the eastern (northern) stream of culture from Asia Minor, where the influences of Mesopotamia and Syria were blended with that of Egypt."

Let us for a moment examine some of the features of Cretan culture. The palace unearthed at Knossos is an amazing structure. In reality the ruins consist of three palaces built up one on top of the other. The topmost palace, in which the Cretans reached the height of their architecture, was " a square building covering about five acres, or as big an area as Buckingham Palace, and had a flat roof. In shape it was a hollow rectangle, with a central court, measuring nearly two hundred feet from north to south, and not quite half as much in breadth. . . . Beyond the west wing there was another court—the meeting-place for the people of the town and the people of the palace ; and out to the north-west a smaller building—the Little Palace—connected with the palace proper by what Sir Arthur Evans has called ' the oldest paved road in Europe,' while a little to the north-east was the Royal Villa." Near the palace was a theatre, whose rising tiers of steps and raised platform have been brought to the light of day. The palace walls were built of gypsum coated with lime-plaster. The palace's system of draining was extremely elaborate. Into the many details of its architecture we cannot enter here. The contemporary palace at Phæstos, excavated by the Italian Archæological Mission, must in many ways have equalled the magnificence of that at Knossos. It was built on a smaller scale but, like Knossos, " consisted roughly of a system of buildings grouped round a central court."

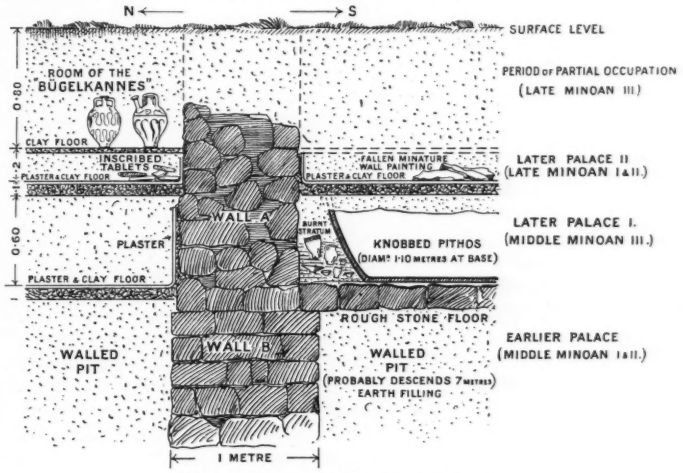
Passing over the ruins of humbler dwellings, with their interesting equipment of lamps and other furniture, mention must be made of the pottery, which has been of great use for determining dates. It displays a wonderful sense of beauty, even amongst the Stone Age predecessors of Crete's Golden Age ; the pottery of the Middle Minoan Period (around 2000 B.C.), with its brilliant colourings and beautiful curves, could not be bettered on to-day, even if it was imitated. Many specimens of fresco-painting and relief work on the lime-plaster of the outer walls of buildings have been found. In the case of fresco-painting brilliant colours were used ; these specimens do not equal the Egyptian methods for elaborateness of detail, but they give a more vivid impression of movement.

Lack of space forbids us to describe the religion, clothing, and social customs of this wonderful island race. The Minoan ladies wore open necks and flounced skirts, and of them a certain French scholar, on seeing some art relics, exclaimed, " Mais ce sont des Parisiennes."

[1] *The Ancient Egyptians.* New and revised edition. (Harper Bros., 6s.)

The Minoans, it may be assumed with fairly considerable certainty, belonged to what archæologists term the " Mediterranean " race ; they, therefore, had " long " heads, oval faces, dark skins, hair and eyes, and, in general, small, but well-developed bodies.

STRATA SECTION FROM PALACE OF KNOSSOS.



(From R. M. Burrows's *Discoveries in Crete.*)

Many questions remain to be cleared up in this field of archæology. We have very scanty details of the relations, commercial and cultural, between Egypt and Crete. We have still less knowledge of how the Minoan civilisation reached Greece. There is a gap of 600 years between the fall of Knossos and the first recorded Greek history, about 800 B.C. Most exciting question of all, " Will the writing of this island race, preserved on hundreds of clay tablets, be solved ? " Its solution would not merely go far to answer the preceding questions ; it would throw new light on the early history of civilisation and result in as amazing revelations as those effected by the discovery of the famous trilingual Rosetta Stone in Egypt in 1799. Solutions turn up in weird, unexpected ways ; it is, for instance, within the realms of possibility that a stone or papyrus giving ancient Egyptian and Cretan equivalents in writing might be found in Tutankhamon's tomb in the autumn, or that some chance traveller in Greece might find a clue from a Greek-Minoan inscription. Who knows ?

EDWARD LIVEING.

THE PROBLEM OF CANCER

Theories and Problems of Cancer. By CHARLES EDWARD WALKER, D.Sc., M.R.C.S., L.R.C.P.

There can be no question but that the widest possible dissemination of knowledge on problems of public health is in the best interests both of the medical profession and the community. It used to be said that every man over forty was a fool or a doctor ; it might be added

that every educated adult man and woman should know at least as much of medicine as they do of public affairs.

This book, a reprint of articles published in *Science Progress*, with additional matter to bring it up to date, is to be recommended, especially at the present time, when a concerted effort is being made to solve the problem of cancer, as a useful introduction for the general reader to the essential features of malignant new growths of the body. We are composed, all of us, of countless millions of unit structures, known as cells, each with individual characteristics, which render them recognisable to the microscopist. Normally, these cells work, grow, and die in an orderly, well-organised manner, duly considering the interests of their neighbour cells like citizens of an unusually disciplined state. The cancer cell—arising from some such normal, healthy ancestor—passes out, in the author's phrase, of "Somatic co-ordination," grows its own way without regard to the interest of other cells, which it strangles and kills with the energy of a raiding band of savages in a fertile country.

The author pays some attention to the supposed variation from the normal of these cells as regards their intimate structure. When a cell divides, and so reproduces itself, its central portion, or nucleus, wherein reside the essential vital features of that cell, splits up into a definite and constant number of strands of dark-coloured tissue, known as chromosomes. This number is the same for all the cells of any one species of animal; there are, for instance, thirty-two such strands in man and twenty-four in the newt. There is only one exception in normal cells, namely, the sex-cells, male and female, which have each only half the normal number of chromosomes. Dr. Walker produces evidence that cancer cells also have only half the normal number. No one who has not studied this particular question is entitled to express an opinion, but it should be remarked that these observations, due to the author himself, have been widely criticised, as he himself points out.

A discussion of the theories that cancer falls into line with diseases such as tuberculosis, and is due to a parasite of some kind, or to various parasites, also occupies a portion of the book. Innumerable features of cancer are absolutely inconsistent with the action of any parasite resembling the bacteria which cause infectious diseases, not least the fact that cancer is not infectious. Of course, the question cannot be settled until the true nature of the disease is demonstrated.

Cancers can be grafted from one individual to another, and this has been done many hundreds of times in mice. But little has come of these experiments, and the resulting growths are not entirely comparable with cancers of natural occurrence.

The cause of cancer is unknown, and the cure, save by early and extensive operation, impossible in practically every case. Sometimes—once in a doctor's experience—a cancer disappears of its own accord; but when it seems to do so, the probabilities are vastly in favour of the diagnosis being wrong. Some facts are known. Prolonged irritation, such as X-ray workers, chimney-sweeps, paraffin workers, and those with decayed teeth cutting the tongue, are subjected to, will lead to cancer. There are as many theories of causation—the eating of every single article of diet, insufficient eating of every article of diet, clothing, washing, and even a wrong mental attitude—as there are ill-informed writers and talkers on cancer. If this book serves to impress the baffling nature of cancer, and the need of the earliest possible recourse to surgical aid on a wider section of the public than is at present familiar with this urgent question, it will have done a work of great value.

R. J. V. P.

PSYCHOLOGICAL TYPES

Psychological Types. By C. G. JUNG, Dr. Med. et Jur. of the University of Zurich. (Kegan Paul, 25*s.*)

The publication in English of a work by Dr. Jung is a welcome and important event, for although it is fairly generally known that what has been called the "new psychology" includes several schools of thought, yet by far the greater amount of literature has been produced by the Freudian school, and in consequence there has been a tendency on the part of the general public to confuse the work of the Zurich school of Dr. Jung with "psycho-analysis," a term that can only be properly applied to the well-defined theories and method of Professor Freud and his followers.

In a preface to the present volume the translator, Dr. Godwin Baynes, explains the difference between the philosophy of Professor Freud and Dr. Jung, but ventures farther and rather unfortunately into the "troubled waters of controversy" in criticising Professor Freud's theories, which he does not present very accurately.

Dr. Jung is more moderate and impartial; he puts forward a classification of human types, with the reservation that it is not intended to be final or exclusive, and that, viewed from other angles, the same types might be grouped differently. The main line of classification is that already put forward by him (in *Papers on Analytical Psychology*) into two "general attitude types," the intravert and extravert. This is a distinction that, when well marked, is easily recognised; the intravert tends to live an "inner," reflective life, the extravert tends to live in "doing," and his interest flows out freely into his environment. Here we may mention Dr. Jung's contention that the Freudian school tends to take the extravert attitude as a standard of normality, whereas the Zurich school regards both intravert and extravert as two normal and probably innate ways of adaptation to life.

In the present volume a further classification is proposed according to the predominance as a guiding element in life of one of the "basic functions" of *thinking*, *feeling*, *sensation*, and *intuition*. Each of these four types may be either intraverted or extraverted, so that the classification is finally into eight separate types.

It might perhaps be said that not much has been gained by mere classification, but Dr. Jung proceeds to show that the predominance of one function is liable to involve the repression of the others and result in a one-sided personality and a faulty adaptation to life.

The repressed functions are not, of course, abolished, but are unable to play an adequate part in conscious life, so that the " unconscious " tends to have (for all individuals) a compensatory function. This implies that, where the personality has become one-sided owing to a great predominance of one function, the balance may be restored by bringing the unconscious elements to light by a process of analysis.

There is a further value to be gained from a better understanding and appreciation of the different types, for time and again the view has been brought forward, a little helplessly, that the clash and bitter opposition between people who " take a different view " of the same facts is due to some personal factor of which neither party is aware. Dr. Jung explains the nature of this personal factor and points the way towards a solution of the barrier of misunderstanding. In a series of long chapters he examines, with a fine sensitiveness and a wealth of erudition, many of the historical conflicts in religion, philosophy and literature, explaining them in terms of his psychological theory. This part of the book is not very simple, but makes far easier reading if the last chapter (of " Definitions ") is taken first and followed by the penultimate (" A General Description of Types ").

F. A. HAMPTON.

PREHISTORIC MAN

Ancient Man in Britain. By DONALD A. MACKENZIE. With Foreword by G. ELLIOT SMITH, F.R.S. (Blackie & Son, Ltd., 12*s.* 6*d.*)

The Horniman Museum and Library, Forest Hill, S.E. From Stone to Steel : a Handwork to the Cases illustrating the Ages of Stone, Bronze, and Iron. Second edition. (S. P. King & Co., for the London County Council, 6*d.*)

In two respects Mr. Mackenzie's *Ancient Man in Britain* stands apart from the growing number of works which deal with the archæology of this country. In the first place, the author follows whole-heartedly in the footsteps of the school of Professor Elliot Smith in holding that the growth of civilisation is not due to an independent development of culture in separate areas, but is the result of a diffusion of culture from a common centre, and that this centre is Egypt. Secondly, he reconstructs the mentality of our prehistoric ancestors, as manifested in their religious beliefs, not merely by the analogies afforded by primitive peoples of to-day, but also by the analysis and comparative study of the myths, traditions, and folk-lore of the inhabitants of these islands.

It would be out of place here to discuss the arguments for and against the theory of the diffusion of culture. Without entering into an examination of the conclusions which have been put forward, it may be said that as a method it has had a profound influence on the study of European archæology along certain lines, and has at least served to broaden the outlook of archæologists. Mr. Mackenzie is, however, something of an extremist, and his readers must be prepared to adopt a critical attitude towards his conclusions. His enthusiasm is apt to outrun his sense of logic.

The scope and method of Mr. Mackenzie's book are well indicated by Professor Elliot Smith in his foreword, when he says: " The story unfolded by British finds is but part of a larger story ; and if this larger story is to be reconstructed, our investigations must extend even beyond the continent of Europe "; and he also lays stress upon the principle of the unity of anthropology, which the late Dr. Rivers emphasised in his Presidential Address to the Royal Anthropological Institute shortly before his death. Mr. Mackenzie has kept both these aims in view, and his wide knowledge of primitive beliefs and customs has stood him in good stead. Among writers on British archæology it is now generally, if not universally, recognised that Britain cannot be adequately studied apart and that Europe must be taken as a whole. Less commonly, perhaps, it is realised that North Africa and Western Asia must also be taken into account. In dealing with the archæological evidence, and with the physical types of prehistoric man, Mr. Mackenzie, while keeping this principle in view, has run to the other extreme. A more systematic and detailed account of prehistoric types and culture would have been useful to the reader who has not all the details at his finger ends, and would have served as an introduction to the evidence for racial and cultural distribution and movement. This is all the more necessary, as the author himself does not appear to have digested his material thoroughly.

Many of the arguments by which Mr. Mackenzie seeks to demonstrate a connection between Britain and the Ancient East are of a highly conjectural nature, and not infrequently far-fetched. For instance, he identifies a goddess of the Hebrides with a goddess of Egypt through a shell and milk cult ; but to point out an analogy is not necessarily to prove a connection.

In dealing with trade relations, Mr. Mackenzie is on surer ground, and although he ignores well-founded criticism of details of Mr. Perry's theories of the relation in distribution of megalithic (large stone) monuments and the occurrence of gold, pearls, and other objects of trade, his summary of the evidence for trading activities in Europe during the Neolithic, or late Stone, Age and the Bronze Age is one of the most useful in the book.

Mr. Mackenzie's analysis of myths and traditions is useful, and indeed valuable, as an account of primitive British belief. But, as already indicated, his conclusions on the comparative side do not convince. The treatment is confused and suffers from over-condensation. Yet the author has gathered together the material for a valuable study. Professor Elliot Smith, to quote the foreword again, says : " The physical character of a series of skulls can give no reliable information unless their exact provenance and relative age are known." The same principle applies to the study of tradition. The heterogeneous mass of material which Mr. Mackenzie gathers together, valuable as it may be as an indication of the character and mentality of primitive man in these islands, is not likely to throw much useful light upon racial questions, until it has been carefully analysed, its

origins traced, and its temporal and spatial relations disentangled.

Dr. Harrison's admirable little handbook to the collections of the Horniman Museum of the London County Council has reached its second edition some seventeen years after its first appearance. It is more than a mere description of the exhibits, and notwithstanding its modest form, it is a sound introduction to the technology and material culture of prehistoric times. It has been brought fully abreast of the numerous discoveries made since its first appearance.

E. N. FALLAIZE.

The Constitution of Matter. By MAX BORN. Translated by E. W. BLAIR and T. S. WHEELER. (Methuen & Co., 6*s*.)

A good book; a compilation by a distinguished hand, well produced and at a very reasonable price. It contains three essays, the first on "The Atom," the second entitled, "From Mechanical Ether to Electrical Matter," and the third, "The Fusion of Chemistry and Physics." These include all the most recent work on the constitution of matter, a subject on which the author is one of the foremost German authorities. The subjects are accurately but briefly explained, the illustrations are good, and the principal references to the literature form a long list at the end of each essay. All this is excellent. It is not easy to see, however, for which class of readers the book is produced. It undoubtedly supplies a want, but whose? The man who will find it most useful is he who has to give a course of lectures on the constitution of matter, for nothing could be more useful as an outline and as an inspiration, than this. But only such a one, one who already knows the subject, will get *all* the good out of it. Research workers in physical chemistry would do well to have this book upon their shelves, but I fear that the ordinary student will find it too elusive, too condensed, too specialised. There are the references, to be sure, but to most students references are just references. They have no time to delve; it is from the book itself that they must get their information.

The book, I have said, is too condensed, and the consequences of this are two. First, important matters that occupied years of research are treated in a few lines, and, second, much that is secondary, but important enough to be mentioned, appears to be of first importance. As examples of the first I may cite the work of Rutherford and of Aston. Aston's work on isotopes gets fourteen lines (but includes a good illustration); Rutherford's on the splitting off of hydrogen from nitrogen gets sixteen lines and a picture. The second brings out a point I have noticed in several books lately translated from the German: English and American workers appear to be outstarted by investigators on the Continent. In this book Moseley appears to be merely one who interposed his work between that of the Braggs and Debyes; G. N. Lewis is hardly mentioned; Sir E. Rutherford is only one of many. On the other hand, Bohr's work is rightly made very prominent, but I think there is too much about Kossel, and few would agree that "probably the best exponent of modern X-ray spectroscopy" is Siebgalin. And cryptic utterances like "[one day] all physics and all chemistry will be a branch of the theory of numbers—the theory of the atomic number z" are best omitted. If this be true, it is true only in the most sophisticated of Pickwickian senses, and only the elect understand it.

But these faults are not very serious and cannot be ascribed to the translators, who have done their work well. On page 34 they have forgotten to translate back the translated title of Rutherford's standard work on Radioactivity. And truer patriots would have put its name before, and not after, that of an Austrian book. For, indeed, if it had not been for the work of this author, first on the disintegration theory and second on the nuclear theory of the atom, there would have been little field for the very clever and distinguished men whose works have made this book. A. S. RUSSELL.

Heat and Energy. By D. R. PYE. (Clarendon Press, Oxford, 5*s*.)

The Clarendon Science Series, a new venture of the Oxford University Press, starts appropriately with a book on Heat and Energy by a Fellow of Trinity College, Cambridge. The series has been designed as a set of readers to form the background of science teaching during the period of general education which stops for most boys and girls at the age of about sixteen. The books are not supposed to be text-books in the usual sense. It is from the latter that the large quantity of detailed facts, which examiners still insist upon, may be learned. But these books aim at concentrating upon fundamentals, in arousing the interests of pupils, in teaching the scientific point of view. A pupil, it is believed, who has become interested in the ideas of science and has been brought to appreciate scientific method is educated in a much more desirable and complete way than the "walking cyclopædia" who never thinks.

This book certainly fulfils the editor's hopes. It tries to give a comprehensive conception of Energy as the basis of all activity in Nature, and to make clear the essential unity of the different forms in which we recognise its existence; to illustrate its convertibility into forms suitable for storage, transference, and use and its final degradation to a state in which, although undiminished in quantity, it is no longer available as a source of activity. It is excellent as regards the general treatment and the information given. It is also written in a pleasant style that carries the reader on. The illustrations are well chosen, but not very well produced. Some of them are rather muzzy, a little bleached, like the appearance of a bank-note back from the laundry after having been inadvertently left in a garment. A. S. R.

Theoretical Chemistry. By PROFESSOR W. NERNST. Fifth English edition revised from the Eighth-tenth German edition by L. W. CODD, M.A. (Macmillan & Co., 28*s*.)

In a short notice scant justice can be done to a work like this one. No short *résumé* can give even the meagerest

notion of the volume's contents. It contains hardly a page that is superfluous and none that is uninteresting. The new edition is now a book of first importance. On subjects like the applications of thermodynamics to chemistry, chemical equilibrium, electromotive force, and others in which Dr. Nernst has been a pioneer, it contains the best descriptions in English. The worst one might say of it is that occasionally the author is uncritical in compiling those parts of the subjects in which he is not particularly interested. But this book is read for Nernst's own work and all of that is excellently put.

The new edition contains rewritten chapters on radioactivity and on the theory of the solid state, and many of the other sections have been revised and added to, in order to bring them abreast of the work that has been done since the last edition, published seven years ago.

A. S. R.

Colour and Methods of Colour Reproduction. By DR. L. C. MARTIN. With chapters on Colour Printing and Colour Photography by WILLIAM GAMBLE. (Blackie & Sons, Ltd., 12*s.* 6*d.*)

This important book should be read by all those who are interested in colour. It gives an accurate and well-balanced account of the whole matter, and in a form that can be understood by those who are not expert mathematicians or great students of physics. The first part of the book aims at giving a simple account of the nature of light, colour analysis, and synthesis, the colours of material objects, colour in regard to illumination, colour in human experience, and colouring materials. The second part is definitely more technical, and deals with the eye and its reactions to light, instruments for colour measurement, colour vision, and colour blindness. The third part, contributed by the editor of *The Process Year Book*, deals with colour printing and colour photography. The book is well illustrated and well produced. If all books on special subjects could be written and produced like this one there would not be much money spent on encyclopædias. A. S. R.

Ductless and Other Glands. By PROFESSOR FRED E. WYNNE, B.A.M.B., D.Ph., etc. (George Allen & Unwin, Ltd., 4*s.* 6*d.*)

A most refreshing work on a subject on which much has been written—much that is learned, much that is "popular," and very much that is sheer insanity. This book is in the best sense of the word popular. It is written in most readable style, begins at the beginning, takes nothing for granted, yet tells all that is established as regards the work of these strange and potent, yet much libelled laboratories of the human body. R. J. V. P.

Practical Bacteriology for Chemical Students. By DAVID ELLIS, Ph.D., D.Sc., F.R.S.E. (Longmans, Green & Co., 4*s.* 6*d.* net.)

This is a really admirable and thoroughly practical handbook, which will suit the requirements of that increasingly large number of students to whom a knowledge of bacteriology is important. It bears the mark of long acquaintance with the difficulties of beginners in dealing with the delicate technique and numerous pitfalls of the science. Any student who carefully follows the full and well-illustrated descriptions of the methods employed to identify bacteria will be soundly equipped for a fuller study of this wide and fascinating subject.

R. J. V. P.

Books Received

(Mention in this column does not preclude a review.)

ARCHÆOLOGY AND ANTHROPOLOGY

The Minoans. By GEORGE GLASGOW. (Jonathan Cape, 4*s.* 6*d.*)

Babylonian Problems. By LIEUT.-COLONEL W. H. LANE. With an Introduction by PROFESSOR S. LANGDON. (John Murray, 21*s.*)

The Banyankole. By JOHN ROSCOE, M.A. (Cambridge University Press, 15*s.*)

HISTORY

The Greatest Story in the World. By HORACE G. HUTCHINSON. (John Murray, 3*s.* 6*d.*)

Links in the Chain of European History. By B. M. RIFFEL. (John Murray, 3*s.* 6*d.*)

An Introductory History of England from Waterloo to 1880. By C. R. L. FLETCHER. (John Murray, 9*s.*)

MISCELLANEOUS

Dreams of an Astronomer. By CAMILLE FLAMMARION. (Fisher Unwin, 10*s.* 6*d.*)

The Works of Aristotle. Translated into English by E. W. WEBSTER. *Meteorologica.* (Oxford: Clarendon Press, 7*s.* 6*d.*)

A Fairy Tale of the Sea. By MACLEOD YEARSLEY. Illustrated by ALICE B. WOODWARD. (Watts & Co., 3*s.* 6*d.*)

Memoirs. By COLONEL SIR RONALD ROSS, K.C.B., F.R.S. (John Murray, 24*s.*)

The Pageant of Greece. Edited by R. W. LIVINGSTONE. (Oxford: Clarendon Press, 6*s.* 6*d.*)

Representative Government and a Parliament of Industry. By HERMAN FINER. (The Fabian Society and George Allen & Unwin, Ltd., 7*s.* 6*d.*)

Child Training through Occupation. By LUCY BONE and MARIE E. LANE. With an Introduction by ALICE WOODS. (Methuen & Co., Ltd., 3*s.* 6*d.*)

ENGLISH LANGUAGE AND LITERATURE

Boswell's Tour to Corsica. Edited by S. C. ROBERTS. (Cambridge University Press, 6*s.*)

Growth and Structure of the English Language. By OTTO JESPERSEN, Ph.D., Litt.D. Fourth edition, revised. (Basil Blackwell, 3*s.* 6*d.*)

PSYCHOLOGY

The Psychology of Reasoning. By EUGENIO RIGNANO. (Kegan Paul, 14*s.*)

An Outline of Psychology. By PROFESSOR WILLIAM MCDOUGALL. (Methuen & Co., Ltd., 12*s.*)

SCIENCE AND MEDICINE

Textile Chemistry: An Introduction to the Chemistry of the Cotton Industry. By F. J. COOPER. (Methuen & Co., Ltd., 10s. 6d.)

Atomic Structure and Spectral Lines. By ARNOLD SOMMERFIELD. Translated by HENRY L. BROSE. (Methuen & Co., Ltd., 32s.)

Studies in Fossil Botany. Part II. Third edition. By DUKINFIELD HENRY SCOTT, M.A., LL.D., D.Sc., F.R.S., F.L.S., F.G.S., F.R.M.S. (Adam & Charles Black, 21s.)

Practical Plant Ecology. A Guide for Beginners in Field Study of Plant Communities. By A. G. TANSLEY, M.A., F.R.S. (George Allen & Unwin, Ltd., 7s. 6d.)

Elementary Zoology. By OSWALD H. LATTER. (Methuen & Co., Ltd., 12s.)

Plant and Flower Forms. By ESTHER J. G. KIRKWOOD. (Sidgwick & Jackson).

Relativity and Modern Physics. By GEORGE DAVID BIRKHOFF, Ph.D. (Harvard University Press; Humphrey Milford, Oxford University Press.)

Vector Analysis. By C. RUNGÈ. Translated by H. LEVY. (Methuen & Co., Ltd., 9s.)

Foundations of Biology. By PROFESSOR LORANDE LOSS WOODRUFF. (Macmillan, 16s.)

Chance and Error. By MARSH HOPKINS, B.A.Sc., M.E.I.C., D.L.S. (Kegan Paul, 7s. 6d.)

The Antiquity of Disease. By ROY L. MOODIE. (University of Chicago Press, $1.50.)

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AXIAL ROTATION

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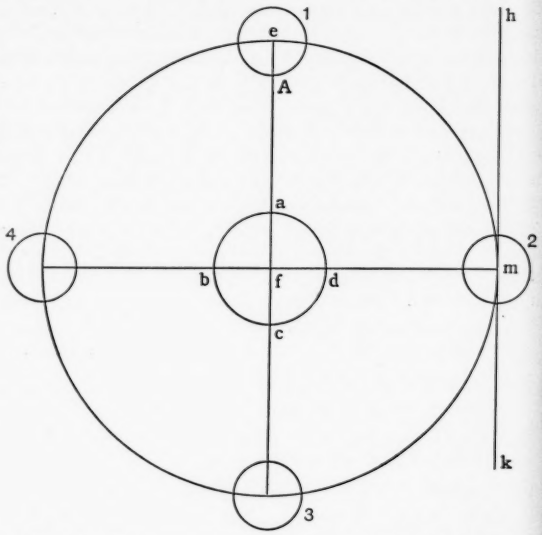

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2, HEATH VILLA,
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LEIGH-ON-SEA.

July 7, 1923.

[This correspondence must cease.—ED.]

SUSPENDED ANIMATION

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The letter, from which the above is taken, was addressed by Mr. Codrington Crawshay, J.P., of Abergavenny, to Professor (now Sir William) Barrett, on May 25, 1897. It may be found in the *Proceedings of the Society for Psychical Research* (Part 32, vol. xiii, July 1897, p. 151).

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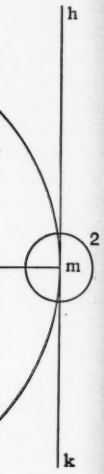

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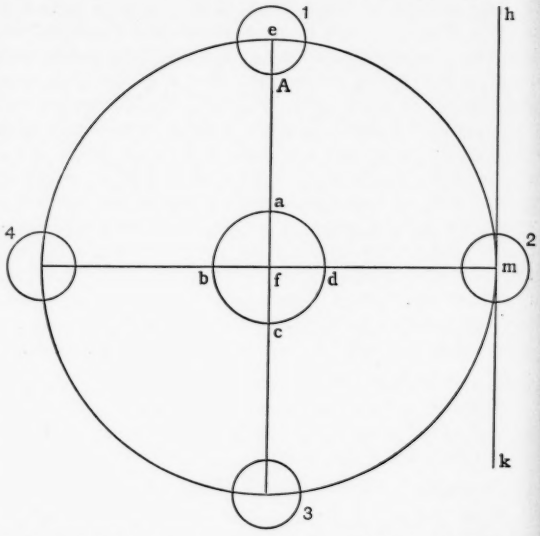

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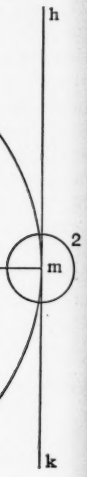

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